NINETY-SEVENTH YEAR

AMERICAN Gas Journal

MARCH 1956

Only Magazine Published Exclusively for the Gas Utility Industry

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memo:

letters to the editor

About Our Popular Communications Series . . .

In answer to innumerable letters already written (and some not written yet) requesting information as to whether the series on better business communications by Dr. Dennis Murphy would be reprinted, the answer is "YES."

There will be 10 to 12 chapters in this series. Chapter 4 appears in this issue. Upon conclusion of the series, we will reprint the complete series in booklet form.

Many thanks to our many readers for their "kudos" on this series.

The Editors

Bouquets & Brickbats On The AGJ Handbook

. . . Handbook is excellent. I find continual use for it.

B. D. Bergie, Gas Superintendent
Interstate Power Company
Alberta Lea, Minnesota

. . . Glossary could be improved.

M. V. Cousins, Vice President
United Gas
Shreveport, Louisiana

. . . over the years, I have found it of inestimable value.

O. H. Simonds, Consultant
New York, New York

Ed Note: Comments on improving the HANDBOOK are greatly appreciated. Our purpose is to provide any data needed in a handy, concise, easy to use form.

. . . book is of material help to company (Manila Gas Company) and they wish to procure five additional copies. Please advise.

Stone & Webster Engineering Corp.
New York, New York

. . . would like to have copy of American Gas HANDBOOK, if available.

J. L. Pulli, Liquid Fuels Engineer
Directorate of Installations
Air Defense Command

. . . could use list of fuel oils by grade showing Btu content per gallon. Also a tabulation of fuel oil prices at various ports of entry.

E. P. West, Jr., Supt., Gas Div.
Department of Public Utilities
Orangeburg, South Carolina

Free 1955 Index Ready

Subscribers desiring a copy of the index to the editorial content of AMERICAN GAS JOURNAL in 1955 may obtain a free copy by writing on company letterhead to AGJ, P. O. Box 1589, Dallas 21, Texas.

NINETY-SEVENTH YEAR

AMERICAN Gas Journal

MARCH, 1956

Only Magazine Published Exclusively for the Gas Utility Industry

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Editor
James A. LeVelle
Engineering Editor
Jan Gartman
Assistant Editor
C. R. Graham
Field Editor
Ernestine Adams
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Donald D. Fickert
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Jerry Stumm
Pacific Coast Editor, RYan 1-5024
1011 South Madison, Pasadena 5, California
Donald M. Taylor
Gulf Coast Editor, JAckson 3-6346
2730 Rice Blvd., Room 236, Houston, Texas
Lewis V. Hohl
Eastern Representative, MUrray Hill 6-7232
52 Vanderbilt Ave., New York, New York
Leo T. Parker
Contributing Editor

•

Joe B. Woods
President and Publisher
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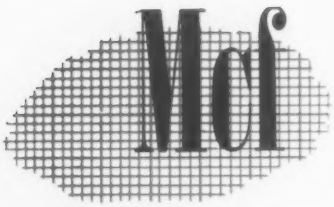


Exemption of gas producers, large or small, is a dead duck issue for this session of Congress. Despite the President's statement that he would consider another bill with more "consumer protection," congressional leaders of both parties feel that it would not pass in the House and that it might be political dynamite. The situation for the next Congress will depend on the political party in power. If there is a Democratic victory this fall, most likely any of the leading Democratic party candidates would veto further legislation freeing the gas producing industry from federal controls. If Eisenhower runs and is re-elected, chances are better. He is on record favoring such legislation if it contains more specific "consumer protection". Such a bill would still have to pass Congress again.

Shades of Noah's Ark! The modern, built-in gas range, which has invaded the home in recent years, has now been designed to fit into the counter top of any galley (kitchen in a boat to you landlubbers). The new sectional range, a two-burner front-and-back job, was introduced at the National Motor Boat Show recently. It uses bottled LPG.

A Supreme Court ruling on whether the FPC must exercise price controls over natural gas resold for industrial uses is expected soon. The decision is due on an involved but important case affecting United Gas Pipe Line Company and Mobile Gas Service Corporation of Mobile, Alabama. In June, 1953, United raised its rate from 10.7 cents to 14.5 cents per 1000 cu ft on gas resold by Mobile to Ideal Cement Company for industrial use. The FPC ordinarily stays rate increases until their reasonableness is determined. But the 1938 Natural Gas Act apparently forbids such stays on gas destined for industrial resale even though hearings could later be held. Mobile said the rate could not be effective without FPC approval. The FPC said United acted within the law. The Third U.S. Circuit Court of Appeals overruled the commission and ordered a refund on any difference between the 14.5 cent rate and the rate eventually fixed by the commission. Both the commission and United appealed to the higher tribunal.

A special Gas Committee has been set up by the Council of the Organization for European Economic Cooperation upon recommendation by the group's recently created Commission for Energy. The new committee will be the first inter-governmental body in Western Europe to specialize in problems connected with production, transportation, distribution, and utilization of gas.

Tennessee Gas Transmission Company stockholders have voted to double the gas transmission company's authorized common stock and to create a new class of 1,000,000 shares of second preferred stock. About 84 per cent of the 14,645,085 shares of outstanding were voted for the proposals and less than 1.5 per cent opposed.

Engineering Construction Company, Tulsa, has been awarded contract to build gas distribution systems for nine Washington state cities and towns. Estimated to cost more than $1,500,000, the construction is for Cascade Natural Gas Company of Seattle. Fish Service and Management Corporation of Houston awarded the contract. Some 400 miles of ¾ through 12-in. pipe will be laid, half of it in Yakima, the balance in the municipalities of Grandview, Granger, Trosper, Sunnyside, Toppenish, Union Gap, Wahpato, and Zillah. Completion is expected by early autumn.

Two new natural gas pipe line projects, involving a total of some $140,000,000 in estimated costs, have been submitted to the FPC for approval. One, filed by Coastal Transmission Corporation, is for a $60,000,000 line from the lower Rio Grande valley area to near Baton Rouge, Louisiana. The 565-mile line would carry an average 350,000,000 cu ft daily for ultimate delivery (through a connecting line) to Florida, last major frontier for natural gas. Another project is an $80,000,000 pipe line that would link the Rocky Mountain natural gas fields (and lines from the San Juan area that traverse the Rockies area) to the Great Lakes area via Natural Gas Pipeline Company of America's mainline from the southwest to Chicago. The project would add 435,000,000 cu ft daily to NGPLA's delivery capacity, an increase of 40 per cent over its present 1,041,000,000 cu ft daily. Most of the gas would be purchased from Colorado Interstate Gas Company, which in turn would buy up to 100,000,000 cu ft daily from Pacific Northwest Pipeline Corporation.

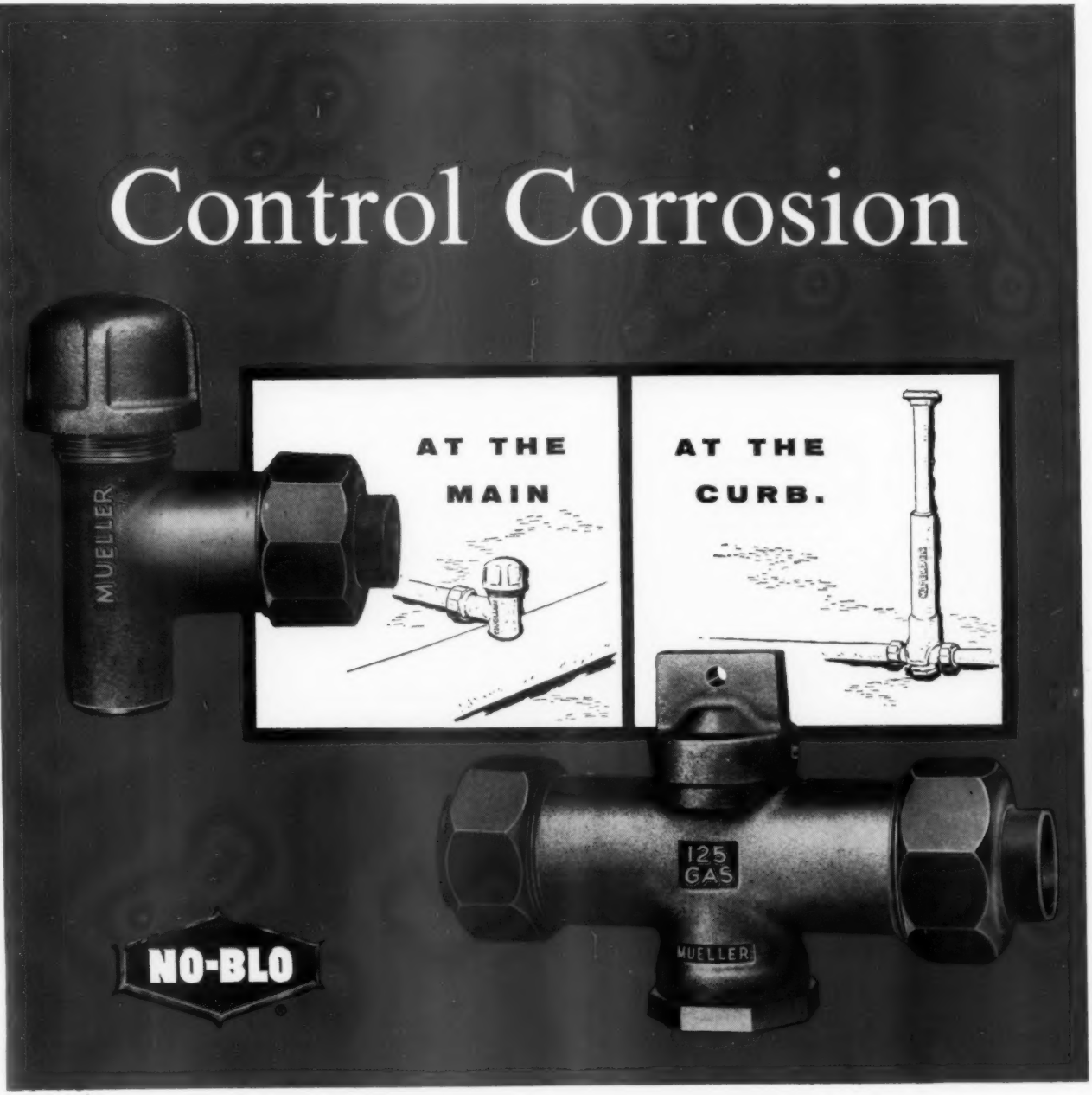
One of the largest contracts ever awarded in the Pacific Northwest for fuel supply has been given by Kaiser Aluminum and Chemical Corporation to Spokane Gas and Fuel Company for delivery of up to 8,200,000 cu ft daily at the firm's two large plants in the Spokane, Washington, area. Largest single use will be to fire remelt furnaces at the Trentwood rolling mill. Kaiser is taking immediate steps to convert to natural gas, which is expected to be available in July.

Northern Natural Gas Company is bolstering its gas supply with the construction of a gathering system and connecting pipe line in Hansford County, Texas, to tie-in with its main line system. Gas will be purchased from 16 wells in the area, delivered through a high pressure gathering system to a centrally-located dehydrating plant, and a connecting lateral line will carry the gas to its main line. Northern plans to substantially enlarge its gas take as the area develops.

Rochester Gas & Electric Corporation is being heralded these days as the "World's Most Beautiful Utility," principally for the appearance of its facilities. The company has been building modern new buildings and doing an excellent job in landscaping them and fitting them to the surroundings. The title of most beautiful was bestowed upon RG&E by the eastern regional convention of the American Association of Nurserymen. An article on one of RA&E's new operational centers will appear in the next issue of AMERICAN GAS JOURNAL.

MAR 13 1956

Control Corrosion



You can control corrosion at the main or at the curb with Mueller® Tees or Curb Stops with insulating coupling. This coupling completely insulates the service pipe from the tee or stop, breaking the galvanic circuit.

Corrosion can be controlled at the main with Mueller Service Tees, Service Valve Tees or Curb Valve Tees that incorporate the insulating coupling outlet to fit steel or Type "K" copper pipe.

Or you can control corrosion at the curb with Mueller Curb Stops with insulating coupling in either or both inlet and outlet to fit Type "K" copper pipe or steel pipe.

If you have Mueller Service Tees or Curb Stops with Dresser Couplings for steel pipe, they can be converted to Insulating Couplings for type "K" copper pipe by using the Mueller H11499 Insulating Adapter Gasket. Contact your Mueller Representative or write direct for complete information.

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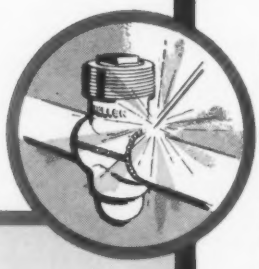
MAIN OFFICE & FACTORY DECATUR, ILLINOIS



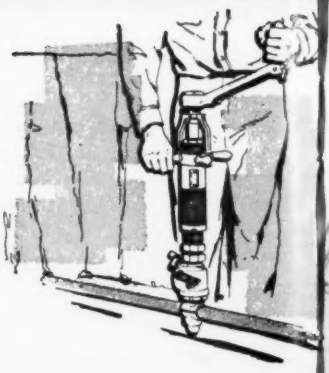
Insert Curb Stops... *under pressure!*

Replace damaged curb stops or make new curb stop installations without shutting off the service at the main. Use a Mueller Line Stopper Fitting to stop-off the service line, cut out a short section of pipe and slip the Mueller Cutting-In Curb Stop in place.

The Mueller Cutting-In Curb Stop carries the same internal design and construction as other Mueller Inverted Key "O" Ring Curb Stops:—125 p.s.i.—flat or square head — iron body — bronze, ground and lapped key — Dresser inlet with Dresser or insulating outlet or threaded inlet with Dresser outlet — sizes ¾" through 2".

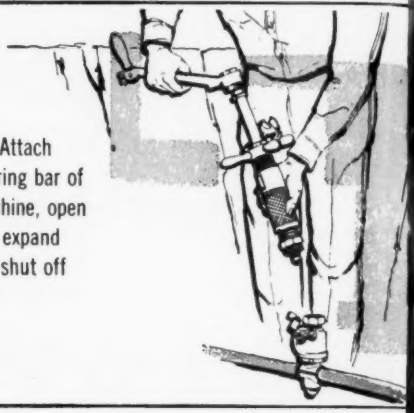
STEP 1

Drill line! Weld line stopper fitting at least 6" from point where stop is to be inserted. Attach control chamber or gate valve and make cut with E-4, T, D-4, or DH-2 Mueller Drilling Machine.



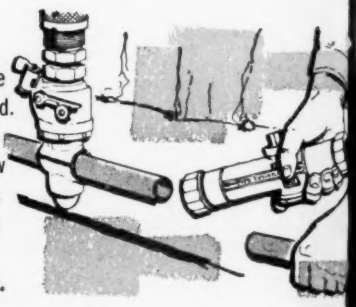
STEP 2

Make stop-off! Attach rubber stopper to boring bar of machine, mount machine, open valve, and lower and expand stopper. Gas is now shut off in service line.



STEP 3

Insert stop! Marks on Cutting-In Curb Stop indicate length of pipe to be removed. (Include existing curb stop, if any.) Slip long end of new stop onto upstream section, then slide other end of stop as far as possible over re-aligned downstream section.

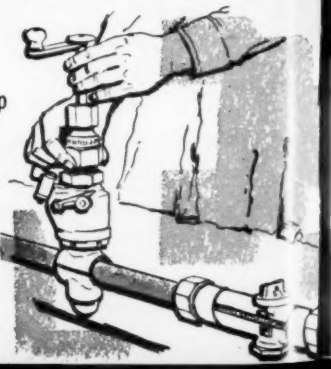


STEP 4

Tighten stop! Downstream section of pipe is now resting against shoulder on inside of stop—this prevents movement when stop is closed. Tighten Dresser nuts firmly. (If threaded inlet stop is used, threads hold stop in position.)

STEP 5

Plug fitting! Close curb stop release and withdraw stopper and close valve. Mount completion machine with completion plug on valve or control chamber. Open valve, insert plug, remove completion machine and valve.



Write for the new No-Blo® Method Booklet, "Safe Operating Practice." It shows how other gas installations are made in a safe manner, without escape of gas.

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Dependable Since 1857

MAIN OFFICE & FACTORY DECATUR, ILLINOIS

STEP 6

Complete installation! Tighten completion plug, attach completion cap and install Mueller Curb Box over new Curb Stop. Entire installation has been made under pressure, without loss of gas and in complete safety.

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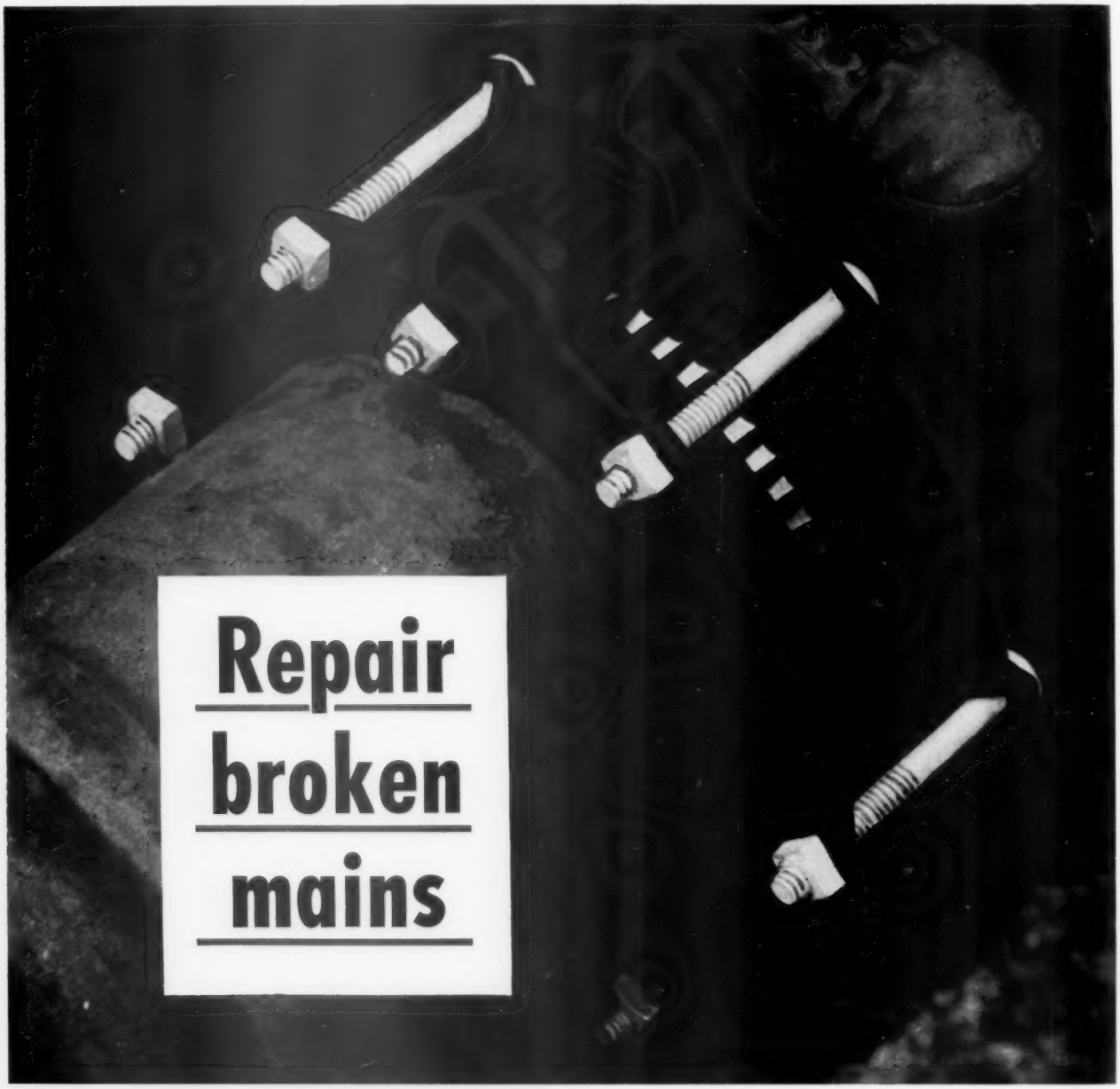

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WRITE FOR CATALOG!

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SKINNER-SEAL SPLIT COUPLING CLAMP

The Law:

Accident or Suicide?

Court Rules on Compensation

By Leo T. Parker
Attorney at Law

Must Prove Suicidal Attempt

A letter recently received from an official of a gas corporation situated in a relatively small city poses an interesting problem. This letter read:

"At various times in the past I have read with considerable interest your writings and review of higher court decisions on compensation awards to injured employees. However, due to the differences in these court decisions and more particularly the kinds of injuries involved, I am confused as to the certain law on this subject. I shall appreciate your further discussion, in more detail, as to why, for example, the amount of damages allowed by higher courts for injuries to employees seems to far exceed the compensation allowable under the State Workmen's Compensation Act. Please list some late damage awards. Also, if and when you locate a new decision involving suicide of an employee, I should like to know how the court will consider claims for compensation by the employee's wife and other relatives."

It so happens that a higher court recently rendered an important decision on the legal question as to whether or not a deceased employee committed suicide.

For illustration, in *Graham v. Nassau and Suffolk Lighting Company, 128 N. E. (2) 813,* the issue presented the higher court was whether the deceased employee, Graham, met his death in the course of his employment by accident, or by suicide.

The testimony showed these peculiar facts: Graham was employed by a gas company, and met his death on the company's premises, during working hours, at a place where he customarily performed the tasks incident to his job as gas maker. A fellow worker testified that he saw Graham running up the ladder leading to a small service platform near the top of the superheater.

The superheater is an apparatus used in making gas. It has a large cylindrical stack 16 ft, 9 in. high and 5 ft in diameter. Affixed to the top of this vertical stack is a heavy iron cover or "clapper" 3 ft 2 in. in diameter. It is fastened by means of a bolt through a hole in its center to a metal arm, which in turn is attached to the side of the stack by a single hinge. The clapper at intervals of about 4 minutes automatically opens upward to a 90 deg angle to release excess gas pressure developed inside the superheater and remains open between one and two minutes. The gas thus emitted ignites when coming in contact with outside air and an enveloping sheet of flame is thrown five or more feet generating a temperature of over 1000 F.

Fastened to the side of the stack is a narrow iron ladder ascending to a small iron platform, the floor of which is about 4 ft 3 in. below the top of the stack. This platform is protected by an iron railing consisting of horizontal members fastened to vertical parts.

In the course of the gas-making operation the clapper atop the stack, which was designed to fit snugly, occasionally gets out of alignment and requires readjustment. Because of the flames and extreme heat caused by the burning gases, the adjustment can only be made when the apparatus is shut down for refueling.

The witness saw Graham climb a ladder leading to near the top of the superheater. This witness further testified that when he looked up again a few minutes later "The next thing I saw was his (Graham's) feet sticking out of the superheater." The charred remnants of Graham's almost completely incinerated body were later taken from the bottom of the superheater.

The Workmen's Compensation Board held that Graham's death was accidental and made award to Graham's dependents of compensation. The gas company appealed and the court *(126 N.Y.S. (2d) 666)* reversed the Board's decision and dismissed the claim holding that Graham had committed suicide, under which circumstances no compensation is allowable.

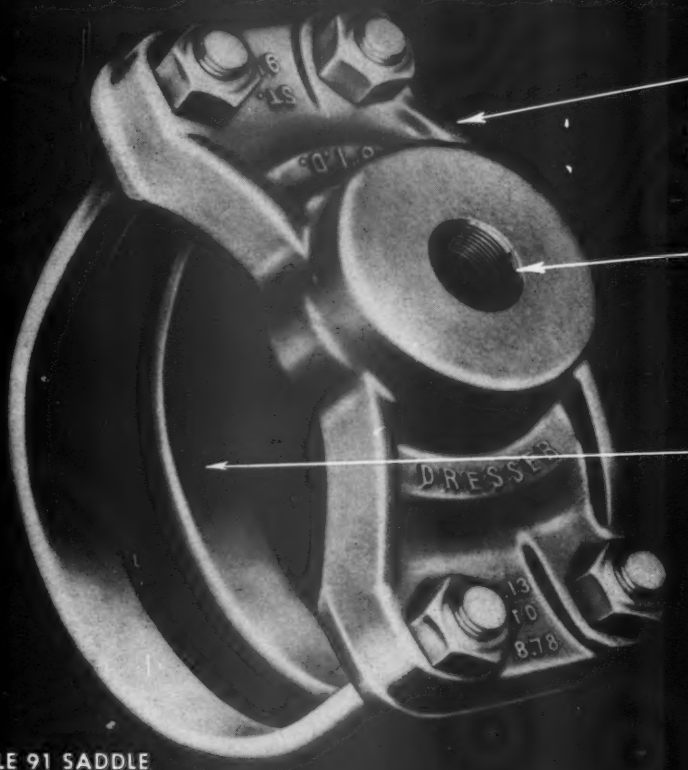
Graham's dependents appealed to the higher court, which decided that the facts were partially unwitnessed. To overcome that finding of the Board the employer had the burden of demonstrating by "substantial evidence to the contrary" that the resulting death was in fact due to suicide.

To meet this burden, the gas company offered hearsay and opinion evidence in the form of the coroner's certificate listing suicide as the cause of death; the opinion of an officer who investigated the accident, and the expert opinion of an engineer who testified that a person of the height of the decedent, standing on the service platform located near the top of the superheater, could not fall into the stack. Also, to show motivation and suicidal tendency, proof was offered to the effect that the decedent (Graham) was having marital difficulties; that his wife had obtained an interlocutory decree of divorce with provisions for alimony and that on the morning in question he was moody and uncommunicative.

It is interesting to observe that the higher court awarded compensation to Graham's dependents, saying:

"Despite this opinion testimony the board was justified in concluding that the decedent's (Graham's) presence at the top of the superheater just before he disappeared into it could reasonably be accounted for as being for the purpose of realigning the clapper. While that function was not part of his assigned duty as crew foreman, it is not at all unusual for an employee to do something other and more than is required of him to his injury. When he does so, he is not penalized, for his right to compensation is not dependent on freedom from fault." ★ ★ ★

NOW AVAILABLE



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FEATURE
American Gas Journal

In a distribution and transmission system assembled with a variety of facilities including all kinds of pipe and construction practices, the problems of providing adequate protection against corrosion are myriad. Here's a case history on how one progressive company is doing it.

Five years of successful operation has convinced Consolidated Gas that . . .

Corrosion Control Pays Off

T. L. Canfield
Corrosion Engineer,
Consolidated Gas Utilities Corporation

UNTIL SEPTEMBER, 1947, CONSOLIdated Gas Utilities Corporation was primarily a gas transportation system. Several distribution systems in Oklahoma and Kansas were company operated; however, the major volume of gas was sold at city border stations throughout western, southwestern, and northern Oklahoma.

In September, 1947 distribution systems in the Southern, Western and McAlester Divisions, were acquired from Public Service of Oklahoma. This turning point in Consolidated history heralded an era of expansion and accompanying problems with which, almost 10 years later, the company is very much occupied.

The transmission system prior to 1950 (approximately 3343 miles of 3-in. equivalent) was composed primarily of dresser-coupled lines with the remainder being made up of welded line and a small amount of screw-joint line. Most of the system was laid in 1928 and 1929 and was treated with a thin, cold-applied, asphalt base, coating application.

Construction of the welded lines came later and coating procedure on them entailed cold-applied, asphalt base and coal tar base coatings, grease coatings, and some hot-applied coal tar enamels.

The lines comprising the transmission system were subjected to diverse and frequently changing electrolytes including several types of clays, loams, sand, gypsum outcroppings, shale, salt contaminated areas, cinders, swamps, streams, sewage waste areas, and crude contaminated areas.

The distribution systems, both existing and acquired, were composed of bare pipe and several systems were combinations of steel and cast iron pipe. During the war years, due to shortage of pipe, inadequately trained personnel, and required new construction, maintenance was, of necessity, neglected for the most part with exception of known leak repair or emergency replacements.

The years immediately following the war brought an even more accelerated expansion of distribution facilities and the necessity for considerable changes and new construction on transmission systems.

Corrosion Control Program

It was apparent that the unaccounted for gas in many of the distribution systems and certain sections of transmission was excessive and that the scheduled replacement program, in many cases, appeared inconsistent when viewed from the standpoint of ratio of capital investment to anticipated return.

Due to (a) the inherent nature of the organization, that is, large capital investment in transmission and distribution plants compared to a relatively small number of meters or accounts, (b) the changing economy brought about by the shift from war-time loads and markets to peace-time status, and (c) the constant increase in cost of labor, materials, and gas at the wellhead, it was felt that a general corrosion control program justified further investigation.

Thus, in 1950, the first steps were taken to provide an organized, coordinated program within the company to combat corrosion.

It was the decision of management that, for the initial phase of the program, a company engineer would be trained in corrosion mitigation and prevention and subsequently head the Corrosion Control Department. To this end, the services of a consulting organization were obtained and a rigorous training period initiated.

The chief corrosion engineer once trained was, in turn, to have the responsibility of training and supervision of additional personnel to be assigned as the demand indicated and as facilities would allow. Until such time as

the scope of the program could be more adequately visualized, it was decided that the department would be centrally located and that technicians would be dispatched as required to the various locations within the company properties.

The long range planning was that, if further efforts and results justified it, division corrosion engineers would be assigned to each division as an integral part of the division organization.

In 1953, it seemed advisable to decentralize corrosion personnel and as a result, division corrosion engineers are permanently located in each of the five major divisions. The division corrosion engineers receive job allocations necessary labor and equipment for survey and installation from the division to which they are assigned. They are responsible to the chief corrosion engineer only for conformance to design, materials and installation policies, and reports and records as required by the chief corrosion engineer.

Early Efforts

At the inception of the program, the system, as a whole, was evaluated on the basis of unaccounted for and known trouble areas and a priority list

EXTENSIVE DISTRIBUTION AND TRANSMISSION SYSTEM operated by Consolidated Gas Utilities was formed in 1947. Providing adequate protection against corrosion has been a big problem because of the many type of pipe and construction practices involved in the various components of the system built over a long period of time.

compiled as a guide by which trained personnel could be best utilized.

As a result, early efforts were confined primarily to main lines scheduled for replacement or those requiring excessive maintenance, river crossings, and compressor station yards. New construction was to be protected as it was accomplished. Very little corrosion control work was done on distribution piping, with exception of new construction, until 1954.

"Hot-Spot" Protection

Due to the large amount of existing, essentially bare dresser-coupled line in the transmission system, it was apparent that the approach to corrosion problems, in most cases, should be that of "hot-spot" protection. That is, the application of small increments of impressed currents distributed along the lines at corroding spots or areas as opposed to the approach of establishing continuity and isolation of long sections of line and attempting to achieve a protective potential over every square foot of pipe surface.

SPS Method Adopted

During the investigation stage of the program, the company was greatly impressed with the use of the *surface potential survey* for the purpose of locating corrosive areas (hot spots) and sections requiring replacement without visual reference to the entire buried structure.

This process consists of tracing direction and magnitude of galvanic current flow through the earth or electrolyte immediately surrounding the buried structure.

Once a survey has been run and the line bell-holed for visual inspection in spots as deemed necessary, it is possible to correlate the survey data and arrive at a quite accurate picture of the condition of the line covered by the survey.

This type of survey is the primary method for designation of anode location on bare lines. Average cost of surface potential survey for transmission lines is roughly $100 per mile.

This engineering expense is felt to be justified considering that,

(a) on a given section of surveyed line, existing leakage (all of which may not easily be visible from the surface conditions) is pinpointed for repair,

(b) corrosive spots on areas, where penetration or failure could reasonably be expected within the immediate or near future, are located and subsequently protected, and

(c) an accurate designation of required replacement sections can be determined.

This last item offers fertile opportunity for savings by eliminating much unnecessary field stripping and excessive footage of line replacement.

Although the magnitude of readings of such a survey will change from time to time, depending on soil conditions the general pattern will remain the same (barring some manmade change in the surrounding electrolyte), thus, survey data become permanent engineering records and are valuable for future planning.

Soil surveys and pipe-to-soil potential surveys alone are rarely used as the basis for designation of magnesium anode locations on bare lines, they are, however, both incorporated into the surface potential survey as necessary factors to be used in correlating survey data with actual pipe conditions.

Frequent use is made of soil surveys over rights-of-way prior to new construction to determine the necessity for, or type of, coating or specific areas requiring coatings.

River Crossing Protection

Major river and stream crossings, normally consisting of two or more bare parallel lines, are insulated at the extremities and are under protection from either windchargers and graphite groundbeds or rectifiers and graphite groundbeds. In 1937, two of the river crossings were put under partial protection with windchargers and junk pipe groundbeds. Some serious and costly leakage occurred, however, in 1949 and 1950. As a result, junk pipe groundbeds were replaced with graphite rods and groundbeds relocated to obtain better current distribution.

Windchargers were left in operation at one major crossing due to lack of power facilities and because of generally excellent, stable wind conditions.

A rectifier supplanted the windcharger at another major crossing and was supplemented by approximately 3000-ft of galvo-line for the purpose of current distribution necessitated by the non-uniformity of soil conditions in this section of river bottom. To date, river and large stream crossings are the only structures under protection using rectifiers as the direct current source.

Future Protection Plans

It is doubtful that much use will be made of rectifiers on future coated and wrapped line construction. Rather, it is anticipated that the company will break such lines into short sections electrically by use of insulating flanges or couplings to minimize the pickup and effects of stray current and to facilitate checking and maintenance of cathodic protection.

Impressed current normally will be furnished from distributed galvanic anode banks, usually on a 10-year design life basis. The use of rectifiers will be adopted for protection of some poorly coated welded lines as the economics involved favor this approach over that of a distributed galvanic anode system.

Coatings for Pipe

A few hot-applied, coal tar enamel coated transmission lines were laid prior to 1951; however, poor application and inclement weather resulted in inferior coatings on these early attempts. After 1951, more rigid control and inspection was exercised on over-the-ditch coating jobs.

A standard coating specification of wire brush and knife cleaning, primer, 3/32-in. coal tar enamel, machine applied; glass fiber wrap, 60-lb kraft paper wrap was specified for over-the-ditch coating jobs. Deviations were made from this specification occasionally to include rock shield or 15-lb felt wrap in particularly abrasive conditions.

A minimum coating resistance criterion of 50,000 ohms per sq ft was established. This standard was based on experience and tests that indicated a coating of this caliber was a reasonably good one, and that the cost of installation and maintenance of cathodic protection by use of sacrificial anodes to supplement this reasonably good coating, would be less than the cost of obtaining a near perfect coating plus the necessary cathodic protection to bring it up to protection.

Mill-Coated Pipe Used

The year 1954 brought a major step forward in the continual battle against corrosion with the advent of the use of mill-coated-and-wrapped pipe as a standard policy throughout the company both in distribution and transmission systems.

The exception to the use of coated pipe was in temporary gathering lines or lines in certain known areas comprised of high resistivity sandy soil where the cost of coating would not be justified, and on certain transmission jobs where over-the-ditch coating was more practical.

It was found that through the use of mill coating and wrapping of pipe, supplemented by cathodic protection, it was possible to go to the use of high tensile strength, thin wall pipe for construction purposes rather than standard weight pipe.

The resultant savings in cost of steel and freight covered coating and wrapping costs and at least part of protection costs. This action was predicated on the basis that the resulting job will have a greatly increased serv-

ice life with a minimum of maintenance.

To date, emphasis has been placed on yard cleaning, coating, and wrapping of inventory pipe until such time as all the new pipe ordered will be coated and wrapped enroute to destination.

Standard mill coating specification consists of shot and grit blast cleaning, primer, 3/32-in. coal tar enamel, glass wrap, 15-lb felt, and kraft paper. Field joints and connections are made with a coal tar enamel, fiber-reinforced tape applied over a coal tar base, cold-applied primer.

Distribution Pipe Protection

New additions to distribution systems are isolated from the bare system and, if size warrants, are sectionalized to facilitate testing and maintenance. Services are insulated at the property line by suitable underground insulating couplings or at the meter by insulating couplings or approved meter nuts. Most service replacements are made with mill coated pipe and protected with magnesium anodes at time of installation.

Long service replacements (over 30 ft) are insulated at both extremities, (if main is bare) the main, and the property line or meter. Three-pound galvanic anodes are used normally on services of this type, regardless of soil resistivity, as the quality coating acts as a resistor to control current output and thus allows ample design life for the relatively small anode.

Short service replacements are insulated only at the property line or meter — not at the main. The anode size in this case is based on soil resistivity and the installation protects not only the service replacement but also a short section of the bare main on each side of the service tap.

Current Practices

Records indicate that, at this time, 21 per cent of the transmission system is under complete or hot-spot protection and 7 per cent of the distribution system is under protection. These percentage figures are based on 3-in. equivalent.

The current trend is the increased use of surface potential surveys in distribution systems for replacement designation and increased protection measures now that new construction and expansion activities are slacking off and more time, personnel, and equipment can be allocated to the maintenance program.

Surface potential survey costs for distribution piping average approximately $200 per mile. The increased survey cost over that of transmission survey costs is a result of slower progress in distribution piping due to abundance of foreign structures and the additional time entailed in readings through asphalt and concrete surfaces.

Again, the engineering cost is felt to be justified to avoid breaking out any more concrete and replacing more pipe than necessary, and to hold to a minimum adverse public opinion due to torn up streets, blocked drives, jackhammer noise, etc.

The Author

T. L. Canfield is head of the corrosion engineering department, Consolidated Gas Utilities Corporation, Lawton, Oklahoma. He organized the company's corrosion control program after serving in the capacity of industrial engineer and division engineer. He is active in NACE activities and has presented and published papers on corrosion surveys and procedures.

Several test installations have been made using plastic tubing as insertions through old service lines. Results have been very favorable and indicate a considerable saving of labor costs can be realized by this means of service renewal. It is anticipated that this process will be utilized to considerable extent in the future.

Minimum Paper Work

It is a rule that no development can be realized without a certain amount of paper work and records and this program is no exception. The company has, however, endeavored to keep paper work to a minimum consistent with what is felt to be adequate information for current and future use.

Technical control (for corrosion control purposes) is maintained by including the division corrosion engineers in the paper-work channel for all proposed jobs within their assigned areas. This assists them in coordinating their activities and requirements for labor and equipment with those of the division and also enables them, if necessary, to recommend any changes in materials or procedure pertinent to corrosion control, prior to actual construction.

Accurate location along with other pertinent information, such as, soil type, anode performance, size and type of line, etc., is made a matter of record on each anode installed and all surface potential survey notes become permanent records.

Special blanket job numbers and charge numbers have been assigned for the purpose of accurately accruing costs entailed in cathodic protection procedure.

Division corrosion engineers and supervisors are responsible for furnishing the necessary cost information to the division auditors. This phase of record keeping is particularly important as the results effect capital and expense accounts and thus have a direct bearing on company earnings.

Economic Studies

An economic evaluation of this type program over a short period of five years duration is a difficult task and, at best, leaves much to conjecture.

It is possible, however, to visualize the effects on the basis of two general categories — immediate returns and prolonged returns.

Immediate returns might apply to instances where the combined procedures of survey, short replacements, and hot-spot protection nullify the necessity of proposed complete replacement of long sections or entire lines.

Prolonged returns are construed to mean those instances where the greatest benefit is derived from possibly two years after installation date through a period of 8 to 10 years, depending on the design life of the anodes. Many installations of the "prolonged return" type are paid out in a period of three or four years, many require much longer.

To evaluate and assimilate all these situations on a partially covered system for a particular time in the midst of varying design life, and interpret this information into dollars and cents is beyond the scope of this article.

Records do indicate, however, that the estimated cost of proposed replacement for this 5-year period, which was subsequently supplanted by corrosion survey, spot replacements, and cathodic protection, exceeds the total cost of the corrosion control program to date. This would indicate that the dollar value benefit represented by "prolonged return" installation is a net figure and that the program value is considerably in excess of the amount expended on it.

In general, the results have been very successful and, as a result, the Corrosion Control Department has become an integral part of company plans and operations.

Much of the credit for the progress which has been made within the organization to date must be given to division management and personnel for their cooperation and interest, and to top management for their initial and continued support of a relatively new concept of pipe lining procedure. ★

ODORIZER VENTING METHOD IMPROVED

By Using Sodium Hypochlorite Bubble Tower

FEATURE
American Gas Journal

John Lederle stands with his hand on the bubble tower filled with sodium hypochlorite. Drums of odorant in the right foreground. The white cylinder holds CO_2 which forces the odorant into the storage tank behind the bubble tower. Directly behind John is the odorant control cabinet. At his feet at left is a supply of sodium hypochlorite.

IT IS NECESSARY, at frequent intervals, to depressure the natural gas odorant storage tank for refilling. In so doing, care must be exercised to prevent the escape of odorant vapors into the atmosphere.

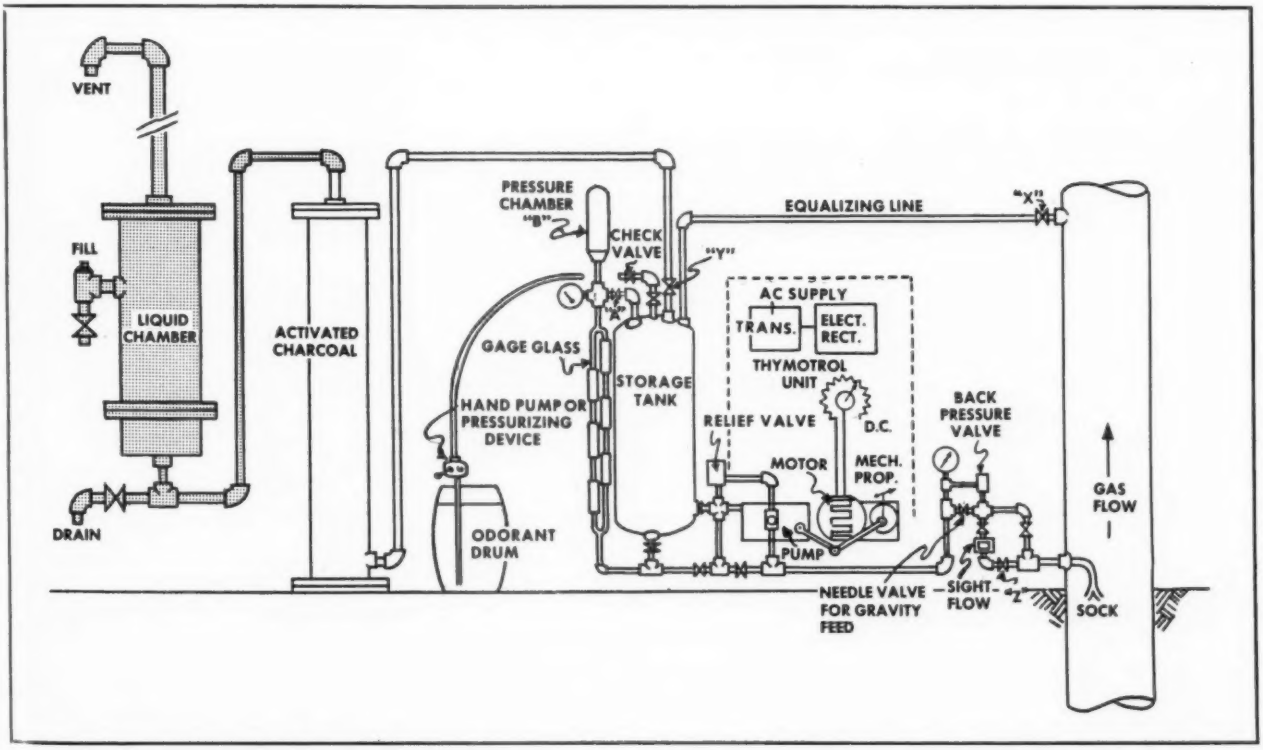
Although the tank is vented through a bed of activated charcoal, there are occasions when this operation proves unsatisfactory.

John I. Lederle, Jr., a controlman at Brooklyn Union Gas Company's Citizen Works, noticed that at times a small amount of heavily odorized gas still passed into the atmosphere.

After studying the problem, Lederle suggested that, after passing through the charcoal bed, the vent gas should be bubbled through a solution of sodium hypochlorite, a chemical used to neutralize accidental spillage of the liquid odorant.

The company realized that the basic idea had good possibilities, and a bubble tower was constructed to try out the method. It was found that fresh hypochlorite solution reduced the odor nuisance to a minimum and the liquid bubble tower more easily serviced than the "char" tower. In addition, the polluted hypochlorite was more easily disposed of than the polluted charcoal.

For his suggestion, Lederle received a $40 award voted him by the Brooklyn Union's suggestion committee.



Operation of the apparatus shown in the above diagram is as follows: Whenever it is necessary to fill the storage tank, the pressure above the liquid in the storage tank must be reduced to atmospheric. Valve "X" in the qualizing line and Valve "Z" in the pump discharge line are closed and Valve "Y" slowly opened. The highly odorized gas from the space above the liquid in the storage tank passes into and through the activated charcoal filter and then through the sodium hypochlorite absorption scrubber. After passing through the hypochlorite solution, the gas is, to all intents and purposes, odorless.

OPERATIONS RESEARCH

Gas utilities are finding scientific methods the best approach to evaluating alternatives

J. E. Hobson and W. J. Platt
Stanford Research Institute

BACKGROUND FOR THIS DISCUSSION stems from two developments: the growing use of the scientific approach in management, and the availability of electronic computers. These two developments can be properly blended into a single concept—that of automation. For automatic systems can be developed only by the application of the methods of science; the analysis and later control of the system are frequently possible only through the remarkable computing abilities of electronic data processing machines.

In order to relate these two developments to operations research, we must have a definition of operations research—and there are many. But perhaps the same individual sovereignty that grants us freedom of speech can be invoked to grant this definition: "Operations research is the scientific approach to evaluating alternatives under management control."

That is the definition used at Stanford Research Institute. All the terms in the definition are important—"scientific approach," "evaluating alternatives," "management control." Possibly the term scientific approach is the most important of all, so we should spend a little time exploring it, discovering what relevance the topic science has to this meeting.

The scientific approach has broken out of its laboratory walls and its use by management on operating problems can have a delightful effect upon something dear to all our hearts—profits themselves. The tremendous technological progess made during the last century has been heavily dependent upon the widespread application of the scientific approach. Until recently, however, the impact of science was primarily upon products and processes, and not upon management and operations. Through operations research the scientific approach is giving us better ways to control and organize business and industrial operations.

At the heart of the scientific approach is the scientist's interest not only in what happens, but how and why it happens. He seeks an understanding of phenomena through certain basic steps:

1. *He states the objective of his investigation as best he can; in short, he asks himself the questions that need to be answered.*
2. *He makes observations and measurements, collects data.*
3. *He develops some trial ideas or "hypotheses" for possible answers to this questions. In operations research this step is called making a "model" of the operation. The model is an analogue, usually mathematical, of the real system being studied.*
4. *He sets up experiments or other tests to determine relationships among the measured elements of the problem; gathers additional data as required; modifies his hypotheses as necessary.*
5. *Finally, he selects the hypothesis that best expresses the relationships involved. He now has a theory, i.e., an understanding of the phenomena. This he can use for either of two principal aims of science: (1) to control nature (the operation, in the case of operations research), or (2) to predict future events.*

All Operating Problems Have "Order"

Operations analysts working in industry and government believe that there is enough order in operating problems to be able to use this same scientific approach effectively. In business operations or military operations, as in nature, it is possible to construct hypotheses or models, to test these out by experimental methods, and then to use the models for control and predictive purposes.

Admittedly, the models in industry and government aren't exact replicas of the real operations because reality is usually so very complex. The same can be said for theories in the natural sciences. So-called laws are merely approximations that are useful in scientific understanding; they require refinement and modification, just as Newton's law of gravity was modified by Einstein. Simplified analogues or models are of value if they resemble reality sufficiently to be used in the purpose desired.

"O.R." Applied to Gas Utilities . . .

Let us illustrate the application of operations research to a problem important to gas utility companies. A simple description of this problem is "how much gas supply should a distributing utility plan and contract for?" Actually this question becomes more complicated when it is examined, because it fairly bristles with alternatives under management control, which was included in our definition of operations research. While these alternatives under management control are familiar to you in the industry, it is worthwhile to set forth some background on them in order to better understand the nature of the investigation.

. . . Must Consider the "Alternatives"

A utility supplies service to its customers on two principal bases: firm

and interruptible. The utility company makes a binding agreement to supply specified amounts of gas to firm customers who have no alternative sources of service. The utility can, with notice, interrupt its supply of gas to interruptible customers, those who have alternative sources that can be substituted when necessary. Rates for interruptible service are naturally lower than rates for firm service.

The practice of operating the two types of service has arisen because of the large daily and seasonal variations in the demand for gas by firm customers. Firm users of gas in Southern California, for instance, consume about seven times more gas on a cold winter day than on a warm summer day. On the other hand, the supply of natural gas flows into a utility system at a relatively constant rate. Therefore, to absorb a relatively constant supply of gas and to even out the utilization of the utility system, the arrangement for interruptible service has been developed.

The amount of interruptible service that a utility will offer and provide is very much under the control of the management. To a somewhat lesser degree the management has latitude in the amount of firm service it will seek. In these respects, then, you can see that there are certainly a number of alternatives under management control.

The next area of the problem in which alternatives exist is the amount of gas the utility should purchase from suppliers, who generally deliver it by pipe line from the well to the entrance of the utility's system. Price at which gas is purchased is affected by the amount contracted for. Incremental amounts purchased later may have an effect upon purchase agreements already in existence. So here, too, is latitude for alternative decisions open to management.

Finally, gas utility company management has latitude with respect to storing or line packing of gas. This may be done when demand is light. Later, stored gas can be withdrawn for sale at times of peak demand, thus better coupling constant supply and fluctuating use. It is by no means obvious, however, that storage should take care of the entire difference between rates of supply and use. This is because it is expensive to store gas in terms of the investment in facilities and in gas inventory. Costs are also involved in injecting and withdrawing stored gas. The comparison of these costs with those involved in the other alternatives is certainly an important responsibility of management.

All of these separated alternatives are actually interdependent. You cannot solve, for example, for the optimum storage schedule without at the same time taking into account both cost and revenue of interruptible sales and costs of various amounts of gas to be purchased from the utility's supplier. Here indeed is a problem with lots of latitude as far as alternatives of management control are concerned; certainly enough to satisfy any interprising operations analyst.

The Southern California Gas Company and the Southern Counties Gas Company jointly asked Stanford Research Institute to study major parts of this gas supply problem. The way the operations research team went about it may serve to put specifics into the scientific approach part of the definition for operations research.

First: Determine Objectives

Recall that the first thing we said the scientist does is to state the objective. In this respect, the American system provides a wonderful final test for the ultimate objective of almost any problem in industry: We seek to maximize profits. That is our ultimate criterion. But we also need to define the questions in detail, so we developed the following list for which are sought either answers or procedures by which the company could be guided.

The first four questions can be classified as strategic or relatively long-range decisions, which do not have to be made every day. The last two are tactical decisions, operating decisions which must be made daily or sometimes hourly.

Strategic decisions:

1. How much annual gas supply should be purchased?
2. How much withdrawal rate capacity should be available?
3. How much injection rate capacity should be available?
4. How much storage capacity should be available?

Tactical decisions:

5. How should interruptible sales be scheduled?
6. How much gas should be stored for sale to interruptible customers?

The next step in the scientific approach is to develop trial ideas for possible answers. We constructed flow diagrams of gas supply, storage, and use. Then we tried to set down in mathematical language the ways in which the system appears to operate. This is the "model" of the gas supply system.

Actually, we wrote several mathematical expressions, among them one to describe relationships among rates of demand, supply, and storage; and another to relate total costs to the variables of purchase costs and storage costs. All these had as a limiting condition the meeting of firm demand under conditions of the coldest winter in recent history.

(Mention of weather encourages us to make an aside on the need in management problems to deal often in probabilities instead of certainties. Fortunately, there is a growing body of probability mathematics and statistics that is very helpful in understanding situations where random influences are present. Through these approaches it is possible to measure quantitatively the gains or penalties associated with playing the game of chance at any level of probability the management may wish to select.)

Returning to the scientific approach, the next step is one of obtaining observations. This is the same problem met in all economics research, that of insuring comparability of cost information for different years and for different conditions. In our gas supply problem the client companies were very helpful in providing data that could be fed into the various models.

Like the scientist, our next step was to test out the relationships and to modify hypotheses when necessary. To undertake this step, operations research analysts had to decide the sequence in which to try for solutions to the strategic and tactical questions described above. While there is interdependence among the questions, one sequence is obviously better than another in avoiding too many successive approximations. The method adopted was first to solve the tactical problems of scheduling interruptible sales and amounts to be stored.

Results were expressed in a series of graphical solutions in which curves for each month in the years 1956-1957 and 1960-1961 were shown. From these curves it is possible to select the rules for optimum interruptible sales and storage such as will maximize profits within all the governing restrictions.

With the tactical problems in hand, it was possible to tackle the strategic problems of solving for supply levels in future years through 1966, giving us simultaneously the scheduled storage requirements. Withdrawal and injection rate capacities could then be determined by providing sufficient capacity to meet peak day firm demand and minimum daily demand, respectively.

The procedures developed here were tested and modified. Now the client companies have a better quantitative understanding of the supply, sales, and storage of gas. They can use these models for prediction and control.

Out-Computed But Not Out-Thought!

Since the scientific approach seeks always to quantify whenever possible, its use inevitably leads to the use of labor saving computing devices. In our opening remarks we said the availability of computers has had a significant effect upon the application and success of operations. Let's spend a few minutes in developing this point.

The development of computers has been made more glamorous than has the application of scientific approach in operations. It is almost frightening to contemplate electronic Frankensteins that can outcompute us.

Note we did not say **outthink** us, for these machines will have to go through many generations of beneficial evolution before they even compete with a moron in thinking.

It has been said that if the apple had fallen on UNIVAC, UNIVAC might have blown a fuse but would never, never have come up with the law of gravity. Perhaps the machines have been overglamorized by the names we give them: ERMA, who is a very efficient bookkeeper developed for the Bank of America by SRI; ORACLE, a computer at Oak Ridge; and now even one called the MANIAC.

These machines have two basic capabilities of interest to industry: first, their ability to handle and process clerical data, replacing routine accounting and reporting; second, their ability to undertake calculations on scientific, engineering, and operations problems.

The first capability is a separate topic for a talk all by itself and cannot be covered here. The second ability, that of making calculations with a speed millions of times faster than by mechanical calculators, is of great importance to operations research. It is one of the scientific "breakthroughs" that permit analysts to use the operations research approach with profit.

Not only can the computer take on the task of calculating the solutions to very complex problems, it can also be programmed to simulate an operation under several sets of decision rules.

A common principle is that nearly all objective analyses of management problems require the use of forecasting in some form. We have already spoken briefly above about the incorporation of probabilistic factors in problem analysis.

This gives us answers in terms of **expected** gain or loss, at the same time providing an idea of the levels of confidence we may place on these expectancies and the cost of obtaining these confidence levels. The ability of operations research to assess the importance of accuracy in predictions is one of the new ideas that is being added to the science and art of industrial economic forecasting.

It is frequently useful to direct a study at finding the cost of each percentage of error in a prediction or forecast. The relationship between cost, or penalty, and percentage of error is seldom a linear function. For example, each percentage of under-estimating a market may carry heavier penalty than the same percentage of over-estimation of the market. When such penalties are determined quantitatively, management has a much clearer notion of the importance of forecasts and how much effort they deserve in the company's scheme of operations.

There are so many alternatives under management control that the utility business is indeed the happy hunting ground of the operations analyst. It abounds with opportunities.

Take the strategic problem of adding capacity to a utility system. Throughout the country the per capita consumption of gas continues to grow. Population growth, particularly in the West, indicates that utilities will continue to expand. The timing of this expansion is important. The amount of capacity to be added is equally important.

Branching out into the customer service side of the utilities industry, we might mention a problem that deserves analytical study — determining the number and location of branch offices. This can be achieved only by getting some understanding of the response of customers as it is affected by size and distance to branch office. Along with this would be an expression of the economics of scale which would define the curve of office efficiency as a function of size. Quite obviously this subject like all others in operations research could be examined only from a system viewpoint, taking into account all the factors that bear upon selecting the optimum alternatives.

Let's come back to something discussed in our first example of operations research, that of optimum supply policy for gas. Gas distribution companies now rely on natural gas for the bulk of their fuel supply. The supply of natural gas cannot meet the growing demand much longer.

To maintain their healthy, growing industry, therefore, the gas companies must develop alternate sources of high Btu gas at a cost which will permit competitive pricing to the consumer. The alternate sources should have a growing usefulness as another method of what you in the industry call "peak shaving"—that is, taking care of the peaks in fluctuating demand.

Various processes can be contemplated for producing high Btu gas. It could come from coal, lignite, residual fuel oil, crude oil, or shale oil. Each of these processes involves byproducts as well as gas. Technical and economic evaluation would be required to select the most promising alternates. Even the determination of which alternatives deserve further study and research is one in which an operations research approach would be valuable.

The determination of rate structures for utility service deserves analytical investigation. In spite of our thinking that utilities tend to be a regulated industry, there is still a good deal of latitude for alternatives under management control to give scope for these investigations. For one thing there is the difference in rates for various types of service, firm and interruptible, and subclasses within each. Analyses are needed that show the sensitivity of the entire system to changes in rate schedules applying to various segments of the market. Aggressive management in the utilities industry does not need to be the captive of precedent and tradition in these matters. A powerful tool of analysis such as operations research can point to bold and profitable new courses of action.

The operating problems approached with the scientific method in operations research are certainly not new. Nor are they straw men set up by and for the operations analyst. Management is making decisions on these problems now, as it has been in the past, and as it will be in the future.

The point is that, without the scientific approach and labor saving computing devices, without mathematical models, management "solves" these same problems intuitively, by "hunch" or "guess."

Operations analysts make no claim to being able to supplant management judgment. On the other hand, management is interested in narrowing that area of decision making in which intuition and opinion are relied upon. Through operations research management can know in advance the probable consequences of adopting eligible courses of action, and can thereby make decisions that will enhance a company's ability to attain its profit goals.

Acknowledgment

This discussion was presented at the AGA annual convention in Los Angeles, October, 1955. ★ ★ ★

How To Correct . . .

Orifice Plate Errors Due to Pulsative Gas Flow

Acoustic method used to develop basis for evaluating amount of deviation

Charles Newman
The Fluor Corporation, Los Angeles, California

A METHOD has been developed for correcting conventional orifice plate calculations for pulsative gas flow. It is based on an analysis of the velocity conditions in and around an orifice plate under pulsative gas-flow conditions and a study of the errors introduced by the use of the assumption of steady-state gas flow conditions.

Conventional calculations of flow rates form orifice-type meters are based on the assumption of steady-state flow conditions. The presence of pulsations requires that a different basic assumption be made, or that a correction factor be applied to conventional orifice calculations. Work of previous investigators[1,2] was concentrated on the errors of the secondary element — the indicating or recording device. Some work[3,4] has been done on the errors of the primary element — the orifice plate itself.

Theory of Measurement

Consider first what measurements might be made on the gas before flow is initiated in it. The molecules are, on the average, at rest. They do have random motion, but there is no set movement of the gas in any direction. Hence, the net displacement is zero. It follows that the net velocity is zero. Also, when there is no flow, the pressure throughout is constant and is equal to the static pressure.

Smooth Flow. When a constant force is applied to the gas from left to right, several measurable changes occur. The particles are accelerated, and as a result, are displaced from their rest positions. This action produces a constant velocity v of the gas from left to right, and now the static pressures at, pipe or flange taps, points A_1 and A_2 in Fig. 1 are no longer equal, but have a net incremental difference. This net incremental difference is a function of the flow velocity v and is the basis of flow measurement by orifice plates.

Pulsative Flow. Now consider what measurements might be made on the medium when a pressure pulse wave is propagated in the medium simultaneously with smooth flow. Again several measurable changes occur. The particles are accelerated and as a result, are displaced from their smooth-flow positions.

The velocity at any point is no longer the smooth-flow value except at certain periods of time during a pulsation. This pulsative particle velocity will be denoted by the symbol u as it is the velocity due to the pulsation only, which is measured over and above any motion of the gas as a whole. Since in present-day use of orifice plates for gas flow measurements, pulsations are longitudinal, the direction of the vibratory motion of the particles is the same as the direction of propogation. Then, the total velocity will be $V \pm u$. It has been experimentally demonstrated[5] that when V is zero (smooth-flow zero) and u has a magnitude, (pulsations present) an orifice plate yields an indication of flow.

Since the orifice plate itself does not recognize direction, and it is eventually necessary to know the relation between the pipe or flange taps on the meter run, points A_1 and A_2 of Fig. 2, the next concept to inject into the theory is the *relationship of net flow direction with respect to the direction of pulse propagation.* Since the net flow velocity at any point in the system is the algebraic sum of the smooth-flow velocity

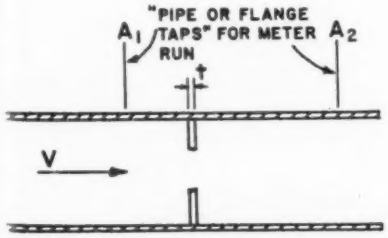


FIG. 1. **Orifice meter run** for smooth flow conditions.

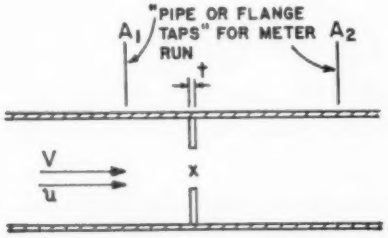


FIG. 2. **Orifice meter run** for simultaneous smooth flow and pulsative flow with propagation in the same direction.

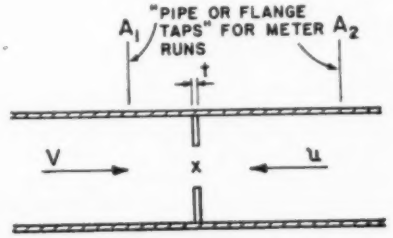


FIG. 3. **Orifice meter run** for simultaneous smooth flow and pulsative flow with propagation in opposite directions.

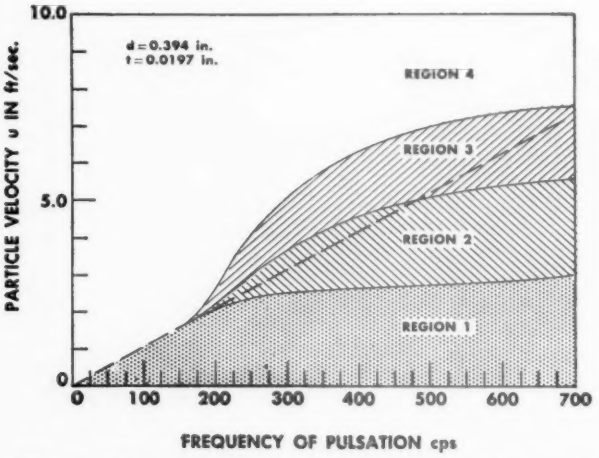


FIG. 4. **Phase diagram** of an aperture showing the regions of different types of circulations and turbulence (Ref.) Ingard.[7]

and the absolute magnitude of the particle velocity $(V \pm |u|)$, $+|u|$ will be used when V and $|u|$ have the same direction of propagation and—$|u|$ when the pulse progagation is in a direction opposed to the smooth-flow velocity. In other words, the notation $(V + |u|)$ means the smooth-flow and pulsative flow originate on the same side of the orifice plate while in the notation $(V - |u|)$ the smooth-flow and pulsative-flow sources originate on opposite sides of the orifice plate.

Using Fig. 2, if the smooth-flow direction is from left to right and the source of pulsations is on the left, the direction and propagation of the pulse will be from left to right. This produces, for smooth flow, velocity V_2 greater than V_1 and for pulsative velocity $|u_1|$ greater than $|u_2|$. Therefore, since both the smooth and pulsative sources are propagating these velocities in the same direction, the net velocity at A_1 will be $(V_1 + |u_1|)$; and the net velocity $(V_2 + |u_2|)$ at A_2, resulting in a velocity error at points A_1 and A_2 with respect to smooth-flow conditions because of the factor $|u|$.

When the smooth-flow direction is from left to right and the source of pulsations is at the right, the direction of propagation of the pulse will be from right to left. This produces, using Fig. 3, V_2 at A_2 greater than V_1 at A_1 for the smooth-flow velocity and $|u_2|$ at A_2 greater than $|u_1|$ at A_1 for the pulsative velocity. Therefore, the net velocity will be $(V_1 - |u_1|)$ at point A_1 and $(V_2 - |u_2|)$ at point A_2, which also produces a velocity error at each point (A_1 and A_2) by the factor $|u|$ with respect to smooth-flow velocity.

Velocity Errors. Since, with field techniques, the measurement of particle velocity is a difficult task, these velocities can be approximated by the measurement of the pulse pressure and computing of the particle velocity at the point of measurement. This is accomplished by the use of the equation[10].

$$|u| = 4637 \frac{|p|}{\rho v} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $|u|$ = absolute root mean square value of particle velocity (ft per sec),
$|p|$ = absolute root mean square value of pulse pressure (lb per sq in.),
ρ = density (lb per cu ft), and
v = velocity of sound in the gas (ft per sec).

However, when it is desired to know the particle velocity at x in Fig. 2, which has no simple means of measurement, the pulse can be measured at the upstream side of the orifice plate with respect to the source of pulsations and then this particle velocity calculation can be corrected by the ratio of the orifice area (S_x) to measuring point area (S_{A_1}), i.e.

$$|u_x| = 4637 \frac{|p_{A_1}| \quad S_{A_1}}{\rho v \quad S_x} \quad . \quad . \quad . \quad . \quad (2)$$

Thus, it can be seen that using Bernoulli's relationship which assumes no pulsations, one can calculate the net flow velocity through orifice plate, and with one measurement of the pulse pressure at the upstream static pressure point, for pulse propagation and net flow velocity in same direction, the particle velocity can be calculated and the velocity error can be determined at the measuring point or within the orifice plate. The orifice plate sees the sum of these velocities $(V_x + |u_x|$ and since it is basically a velocity device, its error is the ratio $(V_x \pm |u_x|)/V_x$. This essentially means that, irrespective of what is done to the secondary element with respect to damping or mathematical gyrations, this velocity error will always be present in systems that have pulsations.

Pressure-Drop Errors. Another method based on the particle velocity of a pulse that can be used to ascertain orifice plate errors was developed through the efforts of a group at MIT[6,7,8]. This group's work refined and added to L. J. Sivian's[9] work of 1935 on orifice plate reaction to pulsative flow. Ingard's [6,7] and Westervelt's[8] work developed the nonlinear relationships and some limits of applicability of these methods to orifice plate analysis for pulsative-flow conditions. The equation developed from Westervelt's[8] work, can be used to calculate the pressure differential across an orifice plate due to pulsative conditions:

$$|\Delta p| = 2318 \frac{\left(|p| \frac{S_{A_1}}{S_x} \right)^2}{\rho C^2 v^2} \quad . \quad . \quad . \quad . \quad (3)$$

where $|\Delta p|$ = absolute pressure differential (lb per sq in.),
$|p|$ = absolute magnitude of pulsation (lb per sq in.),
S_{A_1} = cross sectional flow area at measuring point (sq in.),
S_x = cross sectional area of orifice (sq in.),
ρ = density of gas (lb per cu ft),
C = orifice flow coefficient $(C_r\, C_c)$,
v = velocity of sound in gas (ft per sec).

Since the pressure drop across the orifice is a function of the velocities through the plate, the error ratio is $\Delta p \pm |\Delta p|/\Delta P$.

Limitations. The first limitation is on both methods of calculation of orifice errors. This limitation is on the orifice plate maximum allowable thickness of the measuring section of the orifice plate. In order to visualize the region of applicability of this limitation, a sketch of one of Ingard's phase diagrams is shown in Fig. 4 to demonstrate the various regions: Region 1 and 2 are two types of laminar acoustic streaming; region 3, turbulent motion around the orifice; region 4, where an acoustic jet is formed. Region 4 is the area is which the equations are applicable and the particle-velocity amplitude of the pulsation seems to be the important factor. A critical orifice plate thickness t_c for this region can be defined. This thickness t_c is a function of the particle velocity and frequency of pulsa-

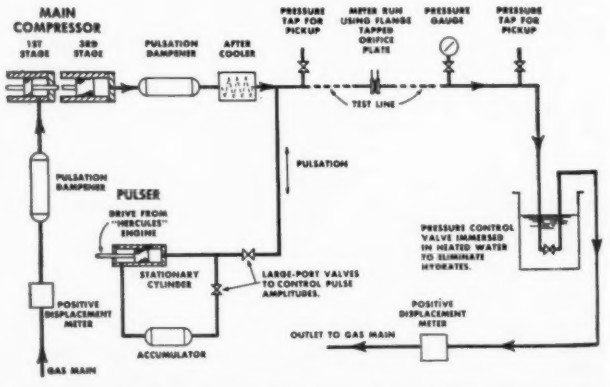


FIG. 5. **Pulsative flow tests** on an orifice plate were made in a laboratory installation as shown by this flow diagram.

tion, and equals the displacement s of the particle due to pulsation. Correspondingly, a critical thickness can be defined as $t_c = s = |u|/2\pi f$, where $|u|$ is the particle velocity due to pulsations and f is frequency of pulsations. Since the orifice plate thickness t is normally less than t_c in gas transporting systems, which use reciprocating compressors, region four of Fig. 4 is normally involved.

The second limitation is with respect to the use of equation (3), which is for pressure drop due to pulsations. This limitation applies to the position of the pulsation source with respect to the direction of net flow and the position of points A_1 and A_2 of Fig. 2 and 3. When operating under conditions as set forth for Fig. 2, there are no limitations as both pulse propagation and net flow are in the same direction with respect to points A_1 and A_2. When operating under conditions as set forth for Fig. 3, there seems to be a possibility of a correction factor necessary to correct for the difference in position of A_1 and A_2 with respect to pulse propagation and net flow direction.

The third limitation is with respect to the use of electrical analogies in the analysis of orifice plate problems. This point bears upon the linearity requirement of resistance and reactance. In electrical analysis, these quantities are linear; and when used as analogies, it is assumed the items they represent are linear. Using the work of Ingard and Westervelt on orifice plates, they can be shown to be non-linear in the region of practical gas transmission where reciprocating-type compressors are used. Therefore, a re-evaluation of the analogy is necessary to account for this nonlinearity.

Application of Velocity Error

In order to show the application of the velocity error theory to orifice plate installations, data are presented from laboratory tests and field installations. A generalized flow diagram of the laboratory installation is shown in Fig. 5. This flow system takes gas through a positive displacement meter from a gas main, compresses it and then discharges it through a pulsation dampener, which removes the pulse developed by the compressor. Flow is now smooth and is fed through an after-cooler to reduce its temperature.

Output of the after-cooler is fed through a length of line that has an orifice meter run as part of its length and then through a pressure-reducing valve and positive displacement meter back into the gas main. At the output of the after-cooler, controlled pulsations are fed into the system from a pulser that controls the frequency and magnitude of the injected pulse. The meter-run line size was 0.5-in. schedule 80 pipe and the orifice plate thickness at the measuring point was 0.02 in. thick. This gave, for the pipe and orifice diameters used, beta ratios of 0.30, 0.37, 0.48 to 0.58.

TABLE 1. Velocity error ratio of Plant A under various operating conditions.

Engines in operation	Stat. press. psig	Flow vel. ft/sec Vx	p Pulse press. (psi)	Vel. error ratio
1, 2, 3, 4, 5, & 6	900	32.3	1.49	1.09
1, 3, & 5	900	16.5	1.19	1.14
1	900	5.5	0.74	1.26
3	900	6.0	1.19	1.38

Orifice diameter = 6.500 in.
Orifice meter run = 12 in. Nom. Sch. 80

TABLE 2. Velocity error ratio of Plant B under various operating conditions.

Engines in operation	Stat. press. psig	Flow vel. ft/sec Vx	p Pulse press. (psi)	Vel. error ratio
1 & 2 D.A. discharge	624	61.2	0.61	1.03
1 & 2 D.A. suction	540	89.0	2.60	1.06
1 & 2 S.A. discharge	895	23.3*	10.00	1.92
1 & 2 S.A. suction	590	86.0	8.15	1.18

Discharge orifice diameter = 4.500 in.
Suction orifice diameter = 6.000 in.
Orifice meter run = 8 in. Nom. Sch. 80
* Two meter runs were used and flow was split.

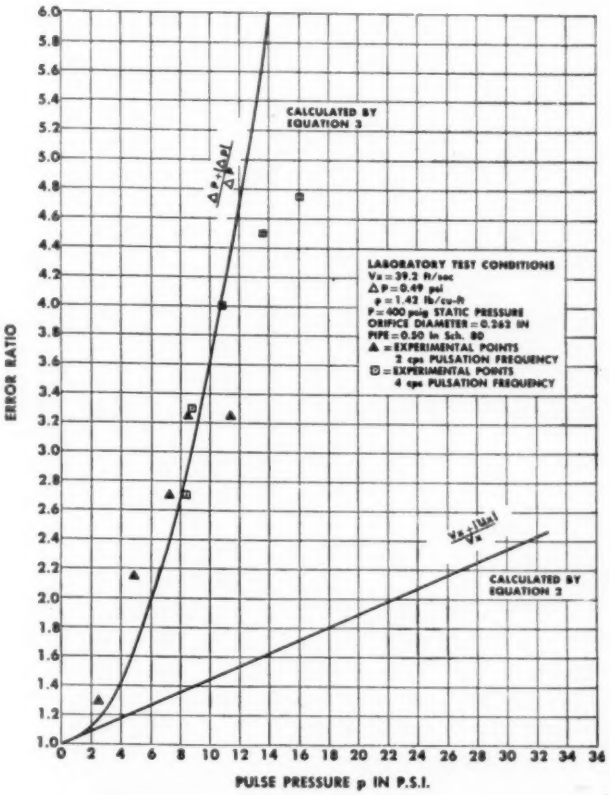

ERROR RATIO
PULSE PRESSURE p IN P.S.I.
CALCULATED BY EQUATION 3
CALCULATED BY EQUATION 2
LABORATORY TEST CONDITIONS
Vx = 39.2 ft/sec
ΔP = 0.49 psi
ρ = 1.42 lb/cu-ft
P = 400 psig STATIC PRESSURE
ORIFICE DIAMETER = 0.262 IN
PIPE = 0.50 in Sch. 80
▲ = EXPERIMENTAL POINTS 2 cps PULSATION FREQUENCY
⊡ = EXPERIMENTAL POINTS 4 cps PULSATION FREQUENCY

FIG. 6. **Velocity error** and differential-pressure error ratio vs amplitude of pulsation.

The theoretical velocity error ratio and pressure-differential error ratio for a typical operating condition of the laboratory system is shown in Fig. 6 with experimental data plotted for the pressure-differential error ratio. This graph shows the velocity error ratio within the orifice place, point x of Fig. 2, and the pressure-differential error ratio between A_1 and A_2 of Fig 2 for pulsative flow conditions on the same orifice plate with varying amplitude of pulsations.

Plant A and B, shown in Tables 1 and 2 respectively, are field installations used for gas storage or transmission, and tests were run on both plants to determine orifice meter errors. Plant A was composed of six reciprocating compressors that could be connected to pump into or out of storage. Tests on this plant were conducted when the compressors were pumping into storage; therefore, the meter was used to measure the suction flow rate. Since basically the velocity error at point x Fig. 2 does not recognize direction, the error is tabulated in Table 1 as a ratio with no indication of direction.

Plant B was composed of two reciprocating compressors that were connected in parallel across a suction and discharge header. Each header system had its own meter run; therefore, simultaneous readings could be taken at both orifice plates. Since the compressors were able to operate both single acting (SA) and double acting (DA), a relationship between these two conditions was obtained. However, during the single-acting condition, it was required to by-pass some gas through another meter system, thereby lowering the flow velocity through the orifice plate, which caused an exceptionally high velocity error ratio. This error is tabulated in Table 2.

Summary

Two concepts have been presented, the first being the velocity error caused by the combination of pulsative velocity and

smooth-flow velocity through the orifice plate. This concept is a linear function $u\alpha(p)$. Field data are given to demonstrate the magnitude this velocity error can attain under pulsative-flow conditions.

The second concept is the pressure differential between points A_1, A_2 in Fig. 2 caused by the pulsative velocity through the orifice plate. This concept is a non-linear function $\Delta p\alpha(p)^2$.

Equations are given for the computations of both pulsative velocity and differential pressure. These equations apply to region four of Ingard's phase diagrams, which are normally the conditions of pulsative flow in gas transmission plants or refineries.

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Coming Up: Three Important Meetings

Southern Gas Association

For the first time in its history, the Southern Gas Association this Spring will hold its annual convention in its headquarters city, the birthplace of the natural gas industry in the Southwest.

L. A. Bickel

Dallas, Texas — the metropolis that natural gas built — will be host April 23 through 25 to the Association's 48th annual meeting. Advance registrations indicate that more than 2000 delegates and visitors from the 14-state area between Virginia and New Mexico will be on hand for the three days of information, inspiration and entertainment.

The SGA's choice of convention city is particularly appropriate. Dallas (and its friendly-fueding neighbor, Fort Worth) were the nation's first sizeable cities to get natural gas for cooking and heating purposes. Lone Star Gas Company, whose headquarters are in Dallas, laid pipe more than 100 miles from its gas wells in Clay County to give Dallas its first gas service in 1910. From a population of less than 100,000 at that time Dallas has grown to an estimated 600,000 — and city leaders agree that the availability of natural gas has been a big factor in this growth. A clean, smog-free skyline has long been one of Dallas' boasts.

Lack of hotel space has kept Dallas from entertaining the SGA until now. The January opening of the country's newest big hotel, the 1001-room Statler Hilton (a hotel run almost entirely by gas) provided the space SGA needs. Convention headquarters will be in the Statler Hilton and Adolphus Hotels.

L. A. Bickel, vice president of Lone Star Gas, Dallas, is general convention chairman, "We're getting a real Texas welcome ready for everyone. This is our first chance in Dallas to show them how we do things here, and I think we'll have a program that will be long remembered," reports Bickel.

General vice chairmen, both from Atlanta, Georgia, are Murray S. Hitchcock of American Meter Company, Inc., and L. H. Ernst of Caloric Appliance Corporation.

Other committee chairmen, all of them from Dallas, are: F. D. Bradley, Southern Union Gas, local convention; J. M. Lynn, Jr., Lone Star Gas, housing; F. A. Garrett, Lone Star Gas, arrangements; Carol Neaves, Lone Star Gas, attendance; B. F. Wombacker, Southern Union Gas, registration; Donald M. Mayne, Servel, Inc., Friendship Hour; Mrs. C. H. Zachry, wife of the president of Southern Union Gas, ladies' entertainment, and Jim Carll, Lone Star Gas, publicity.

American Gas Association

The 1956 AGA Sales Conference on Industrial and Commercial Gas will be co-sponsored by the Southeastern Gas Association and the Southern Gas Association at Hotel Roanoke, Roanoke, Virginia, April 17 through 19.

The three-day conference will open with Industrial Gas Day on Tuesday, a general session on Wednesday, and Commercial Gas Day on Thursday. There will be specific topics presented for industrial gas men and reports of sales and campaign plans and case histories for commercial gas men.

A diversified selection of subjects will include sales, promotion and research activities, as well as a gathering place of information on new products and processes, and will provide an ideal opportunity of getting together on mutual problems.

On Monday, April 16, there will be meetings of the Metals Committee and the Industrial Processing Committee. Friday, April 20, the Food Service Equipment Committee and its four subcommittees will meet. Also on Friday, the Commercial Processing Committee and its subcommittees will meet.

New England Gas Association

The 30th annual meeting of the New England Gas Association will get underway March 22 in Boston's Hotel Statler with election of officers, presentation of NEGA awards and an address by Harold E. Ayer, NEGA president.

Panel discussions, floor discussions and a National Gas Industry Panorama will be featured during the two-day meeting.

Outstanding leaders in the gas industry and public relations fields will lead the panel discussing Building Desirable Group Relationships, Thursday afternoon, March 22. Friday morning, March 23, Master of Ceremonies William B. Hewson, Brooklyn Union Gas Company, will introduce speakers for the National Gas Industry Panorama.

Cooperating With Our Industry Allies will be the topic discussed by the panel Friday afternoon. This panel will cover residential, commercial, and industrial area cooperation.

Andrew W. Johnston, Boston, Gas Company, is the 1956 chairman of the program Committee. Vice chairman is George R. Copeland, Algonquin Gas Transmission Company.

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Fourth of a Series

Communication:

How to Manage Sentences

Dr. Dennis Murphy

A BUSINESS WRITER should have two objectives constantly in mind:

1. **keeping his whole purpose clear and**
2. **making each sentence carry his meaning forward.**

A sentence is a word-group that carries a unit of communication. Each sentence we use should (a) form a complete unit in itself and at the same time (b) further the continuous flow of thought. We communicate with word-groups in a context, each group like a link in a chain — bound to what goes before as well as to what follows.

This article sets forth a few guiding principles that can help us make sentences go straight and clear. It also suggests how to improve them through careful revision. Every writer, however, will need to practice hard to master his craft.

Always Remember Mr. Reader

To get our communication job done accurately and effectively, we should think more about **what** we're saying than about **how** we're saying it. Both are important; but it's much better to write sense awkwardly, even poorly, than to write nonsense grammatically and gracefully. Good writing is like a straight line: It's the shortest distance between two points — writer and reader. And it should be good sense expressed sensibly.

Too much concern about **how** we express ourselves can lead to a self-conscious manner that's stiff or unnatural. Likewise, too much revising can knock all the spontaneity and life out of a sentence.

At the outset our reader will ask, *"What's this about?"*

First, he wants to get the **content.** Then while reading he'll notice the **form** — order, development, sequence, flow, tone — especially if the form is bad! When he finishes reading he may check the **effect** by asking himself whether he should ponder the message, go into action, or forget it.

Thus our purpose is clear: **make content and form work together to produce the desired effect on our reader.**

Getting Started

Knowing exactly what to say is half the battle. But how do we get those definite thoughts before we begin? Here are three tips:

1. **Turn the problem over in your mind**
2. **Talk it over with somebody else**
3. **Pencil some kind of rough outline**

If we just start writing, we're likely to wander, repeat, and get all balled up. When we do, even our best ideas sound half-baked. True, writing and rewriting help to clarify points, but we should think first to crystallize our ideas — before we ever put pencil to paper or start dictating.

Too often business writing falls into routine patterns. Actually, many of us get into the habit of wording our sentences a certain way until we can hardly word them any other way. Breaking the tiresome order of subject-verb-object is seldom done. To begin a sentence with conjunction, infinitive, phrase, or adverb is to commit sacrilege. And ending with a preposition is frowned on. So look what we're up against. Any machine or method used for 20 years in our fast-moving world is ready for replacement or change. But what about habit-thinking that keeps us in a rut for 20 years?

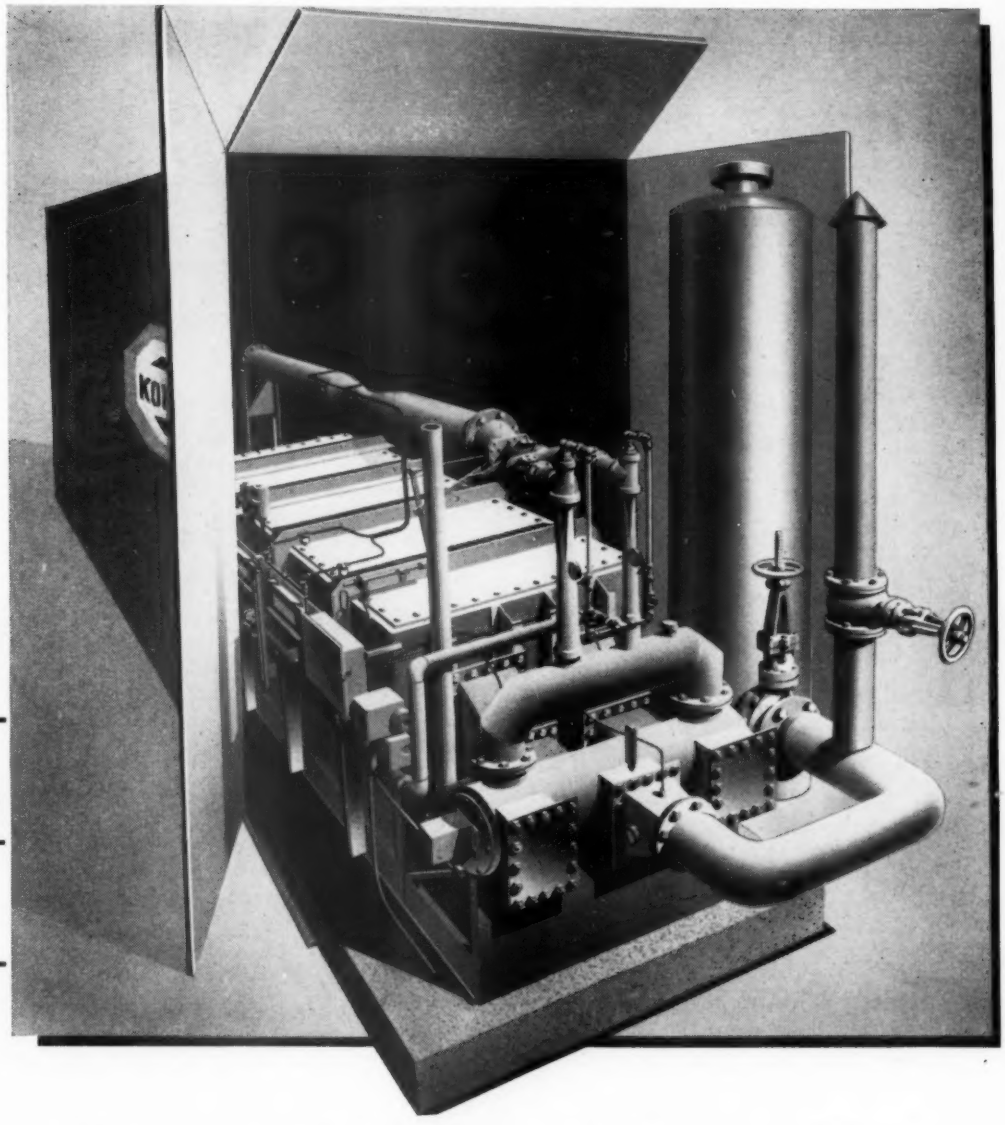
Use All Kinds of Sentences

Most of us may recall that sentences make a statement *(declarative)*, give a command *(imperative)*, ask a question *(interrogative)*, or exclaim about something *(exclamatory)*. About 99 per cent of all business sentences either make informative statements or give instructions, but we can add a sparkle by occasionally using a question or an exclamation. Then why not try it?

Many **loose** sentences ramble on,/ like this one,/ and lose their emphasis/ because they keep adding another idea/ and then another/ but could end/ many times/ before they finally do.

In contrast, a **periodic** sentence, like this one, is incomplete until the reader, held in suspense, reaches the very last word.

A **balanced** sentence poses one thought against another; it presents compactness with force. About 95 per cent of our



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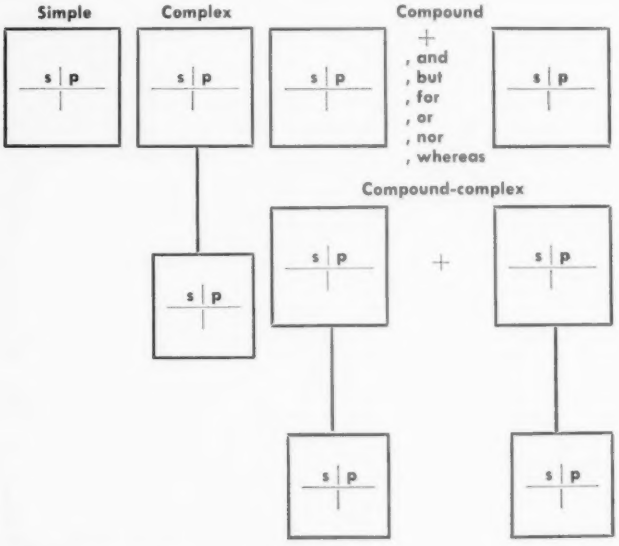
sentences are loose ones, but we should use all three types.

As to structure, a **simple** sentence has one subject and one predicate. A **complex** sentence has one main subject and predicate but also one or more dependent clauses. A **compound** sentence has two or more complete co-ordinate statements. If either or both of these has any dependent clauses, the result is a **compound-complex** sentence. Again, too many business sentences are compound-complex.



Brevity Is the Soul . . .

Keep your sentences short. They shouldn't average over 20 words. This doesn't mean that a 40-word sentence is poor if it is well knit, runs along smoothly, and is easily understood. You may need several unusually long sentences, but follow them with a short crisp one.

Too many choppy sentences, like riveters with their rat-a-tat-tat, grow monotonous. Too many long sentences, on the other hand, overloaded with details and exceptions and other ramifying if's or and's, bog any reader down and make him do a lot of backtracking to get the meaning. Vary the lengths. If you put your reader to sleep with a long one, wake him up with a short one. It carries punch at the end of a paragraph. It's like the cherry in a Manhattan!

Keep useless words out. "Be careful that you write accurately rather than much," said Erasmus. Especially when you're getting started, beware of prolixity. If the first page is waste motion, like a baseball pitcher's windup, throw it away. Dive right into your subject. Cut out repetition, and start a savings account with words. Notice these:

1. *In regard to the various and sundry reasons whereby Benjamin Franklin became not only eminent but also famous, there are at least several very good reasons. (26 words)*
   (Franklin became famous for several reasons.) (6 words)
2. *Actually he succeeded in landing the fish, otherwise known as a trout, in a way that was really very skillful. (20 words)*
   (He landed the trout skillfully.) (5 words)

Six Principles of Sentence Management

The following principles, sifted from dozens of "rules" on writing, are basic. If you master these six alone, you can correct 90 per cent of your sentence errors. Not bad, eh? Examine the faulty sentences; improved forms are in parentheses.

AID 1: *Make the Subject and Its Verb Agree*

1. Your **request** for prices of best-grade Bethlehem steel

in the 40-foot joints of 16-inch pipe **have been received.**
(We have received your request for prices of . . .)

Always use the active-voice verb instead of the passive, if you can.

2. The fantastic **paradox** of farm prices, on a toboggan slide while living costs soared skyward, **have ceased.** (Paradox have?)
3. The **supervisor,** as well as the foremen and group leaders, **are** here.

When you allow the subject to get widely separated from its verb, you flirt with trouble. Other nouns, singular or plural, come in between — and throw you off the track.

4. Tax **reductions** that went into effect last year **was** most helpful.
5. **Reports** that the crude oil would gel at low temperatures and then immediately liquefy when agitated in any manner **was investigated.**
6. The final **copies,** which go to his office for approval and distribution to each department and the field, **is** not ready.

Notice the use of **that** and **which** in the last three sentences. This might be a good place to point out their difference, a difference that seems to baffle 95 writers out of 100. **That** is restrictive and preferred in a clause that can't be omitted; **which** is non-restrictive and preferred in a clause that adds by-the-way information. **That** requires no comma before it; **which** does.

7. This is the machine **that** sold for $5,000.
8. This machine, **which** was manufactured in Canton, sold for $5,000.
9. Washington, **which** is our national capital, is growing rapidly.

You may use words in apposition rather than a which-cause.

8. This machine, manufactured in Canton, sold for $5,000.
9. Washington, our national capital, is growing rapidly.

Like these better? Then you might try "which-hunting" among your own sentences.

AID 2: *Avoid Needless Shifts in Structure or Direction*

One common tendency is the unconscious change of construction midway in a sentence. Lincoln's famous advice, "Don't swap horses in the middle of a stream," is equally good here. Think through the entire sentence before you begin; if you can't hold that much in mind, maybe you're including too much. Better have three short clear units than one long jumbled one.

Once you launch into a sentence, hold to the same subject, tense, and point of view. If you set up one subject but tear it down to set up another and another, **you force your reader through a maze of psychological adjustments.** Why make him go through unnecessary mental processes?

Don't Buy Any

Tractor Mounted Back-hoe

Until You See

The New 1956

Sherman Power Digger

at Your

Ford Tractor Dealer

1. Any **man** who might accomplish this task, the whole **company** would consider him to be a genius, because that **job** is certainly not easy.
   (The man who could accomplish that tough job would be a genius to the whole company.)
2. This **heater** burns less oil, and at the same time the **salesman** says they can be cleaned easier, yet the **price** is relatively moderate.
   (The salesman says this heater burns less oil, is easily cleaned, and is moderately priced.)

Keeping the same direction in a sentence, too, makes reading a lot easier. Conjunctions like **therefore, consequently,** or **so (and so)** propel your idea forward; words like **nevertheless, but** or **yet** throw your idea into reverse and pull it backward. Try not to change your direction more than once.

3. Operations were delayed for a short time, **but** we knew our power would be limited, **for** we had anticipated this breakdown, **but** operations were disrupted only 12 hours.
   (Operations were delayed a short time and disrupted only 12 hours, because we anticipated this breakdown and knew our power would be limited.)
4. Playing football teaches a young man how to be alert, not to shirk their responsibilities, and they learn what to do in an emergency.
   (Playing football teaches a young man to be alert, self-reliant, and resourceful.)

Keeping a parallel structure makes easy reading. When you have several relatively parallel ideas, make them all go the same way. That is, put them all in the same construction—infinitives, gerunds (verbal nouns), phrases, clauses, participles, or what-have you. In sentence 4 the ideas of alertness, self-reliance, and resourcefulness go every which way. That slows up any reader.

AID 3: *Watch Every Pronoun's Reference and Agreement*

No word causes more trouble that the little pronoun. Because it always **refers** to some noun, it must always **agree** with that noun.

Wrong Reference:

1. Everybody should mind their own business if they wish to succeed.
   (Everybody should mind his own business if he wishes to succeed.)

Mixed Reference:

2. You'd better see Evans than Jones because he's busy right now.
   (You'd better see Evans because Jones is busy right now.)

No Reference:

3. He didn't hear the whistle, which was due to his deafness.
   (He didn't hear the whistle because of his deafness.)

Loose Reference:

4. The bottle must be kept clean for the baby; so, after feeding it, sterilize it with boiling hot water. *(Wow, poor kid!)*
   (The baby's bottle must be sterilized after each feeding.)

Ambiguous Reference:

5. The employer told the employee that he would ruin his reputation if he didn't rewrite his letter.
   (Better use a direct quotation here: The employer said to the employee, "You'll ruin my reputation if you don't rewrite . . .")

Sometimes you can manage this kind of sentence by putting one noun in the singular, the other in the plural.

The employer told the employees that they would ruin his reputation if they didn't rewrite his letter.

Can you tell whether each italicized pronoun below is in the right case? Mark each sentence R or W (Right or Wrong).

1. Nobody but Bill and *me* was left on the job.
2. The winner was thought to be *he*.
3. They believe the culprits to be *us*.
4. I don't recall *his* going into the office.
5. He is the man *who* we believe did it.
6. We can drill for oil as well as *them*.
7. We'll cooperate with *whoever* you choose.
8. Give it to *whomever* fills out the blank.
9. The boss invited my wife and *I* to attend.
10. Between you and *I*, *whom* do you think broke the machine?

(Answers: the first five are right; the last five are wrong.)

AID 4: *Look Out For Dangling Modifiers and Misplaced Words*

No sentence sounds sillier than one with dangling modifiers. Both participles and infinitives are verbal forms that modify a noun. The trick here is to make sure that we use the **right** noun for each to modify. We may as well have some fun while we learn from these ludicrous examples:

1. Enclosed, please find . . . **(You** *is the understood subject.)*
   Attached, please find . . . (Are **you** *attached or unattached?*)
   Under separate cover, please find . . . (*Twin beds, you see.*)
2. After trying in vain to reach you by telephone, this letter will notify you of your appointment. *(Who was trying in vain?)*
3. Referring to your letter of March 17, the cost is itemized below. (*Is* **cost** *doing the referring? Referring to your letter of March 17, we have itemized the cost below.*)
4. To balance our figures, fuel oil in the sales column is included.
   (To balance our figures, we include fuel oil in the sales column.)

More dangling participles:

5. When thoroughly stewed, you will like these prunes. *(When thoroughly stewed, these prunes are delicious. Or maybe, when thoroughly stewed, you will like anything!)*
6. Clogged up with coffee grounds and frozen solid, the plumber was called in to repair the drain pipe. *(Poor plumber!)*
7. After bolting my sandwich, the plane took off. *(Hungry plane!)*
8. Doing 60 mph with the cut-out open, a Jersey cow collided with his Buick at Fourth and Main, causing a great spill. *(I'll bet.)*

Dangling phrases:

9. After a brisk swim, hamburgers and beer always hit the spot.

10. The marshal keeps a record of all fires started by pyromaniacs in his desk drawer.
11. A blonde secretary entered the room with the largest freckles I've ever seen.
12. FOR RENT: Bedroom by refined lady with sunny exposure for two businessmen recently plastered. *(Supply your own remarks here.)*

AID 5: *Coordinate Equal Ideas; Subordinate Less Important Ones*

This principle sounds easy, but it requires a good deal of weighing values to determine logical relationships. The most important idea should be put in the most important position. in the sentence — that is, first or last. Parenthetical elements, like **furthermore** or **in fact** or **if we are not mistaken,** should be tucked in somewhere in the middle. Notice these:

Of course, this statement is true. *(Is* **of course** *a transition?)*
This statement is true, of course. *(weak ending)*
This statement, of course, is true. *(Best)*

The longer a sentence is, the harder it is to evaluate ideas in it. And any isolated sentence is almost impossible to evaluate because we can't tell what to play up, what to play down. Without knowing what's gone before or what follows, we don't know what is intended. But let's do the best we can.

Faulty coordination (all ideas are equal):

1. I have a dog, and he's a setter, and he's black and white, and I found him dead when I came home yesterday.
   (I found my black-and-white setter dead when I came home yesterday.)
   Dead, the all-important word, is still buried in the middle. Let's try for emphasis at the end.
   (When I came home yesterday, I found my black-and-white setter — dead.)
2. The next step is the laying of the foundation, and it must be constructed of concrete, and our men can do the mixing of the concrete.
   (The foundation must next be laid of concrete, properly mixed by our men.)

Faulty subordination (major idea in minor position):

3. We were returning in the truck when the explosion and fire occured.

Main idea	Subordinate idea
(The explosion and fire returning in the truck.)	occurred when we were
Main clause	Subordinate clause

AID 6: *Beware of Faulty Comparisons*

Comparison and contrast are two vivid and useful devices in writing. Managing them is easy when the thinking is clear, but they cause trouble when they are illogical, ambiguous, incomplete, or ungrammatical.

Illogical comparison:
Cleveland is larger than any city in Ohio.
(Cleveland is larger than any other city in Ohio.)
Since Cleveland is a city in Ohio, how can it be larger than itself?

His salary was lower than a typist.
(His salary was lower than a typist's.
Or, His salary was lower than that of a typist.)

Ambiguous comparison:
Is Chicago nearer New Orleans than New York?
(Is Chicago nearer New Orleans than New York is?
Or, Is Chicago nearer to New Orleans than to New York?)

Incomplete comparison:
Try Westinghouse — it's safer. *(Safer than what?)*
He ordered wine because he thought it was better for him. *(Than what?)*

Ungrammatical comparison:
Production in 1955 was as large, if not larger, than in 1954.
(Production in 1955 was as large as in 1954, if not larger.
Or, Production in 1955 was as large as, if not larger than, in 1954.)

Paragraphs Are Built

The first sentence in a paragraph of business writing usually carries the most important idea. Called the topic sentence, it resembles the hub of a wheel or the central core of a modern building. Like spokes of the wheel or conduits of the building, other sentences lead from it, refer to it, and develop it. These related parts give the whole paragraph a unity. Transitional elements, of course, give it coherence. And by unloading the most important idea first, we help the hurried businessman to skim and get the meaning quickly.

Here's a picture of the preceding paragraph:

topic sentence
developing sentences

Keep your paragraphs short. The 90-word paragraph above contains six sentences whose average length is 15 words. That insures easy reading. Most business material, however, is more difficult than this. But that's all the more reason for breaking it up into short digestible units. So, try to hold each paragraph under 100 words; if they run from 200 to 400 words each, they're too hard for the average reader to struggle with. Remember, he reads on the run and needs to understand in one reading.

Don't Worry About Style

Yes, you want your sentences to have correct grammar, structure, punctuation, and spelling. But style never depends on correctness. It depends on hitting the right tone, the right frame of mind. So become aware of your tone — your attitude toward the reader, your feeling about the subject, and the spirit you want your words to communicate. As a man thinketh, so is he.

Nothing communicates your nature more accurately than your language. It always reflects you like a mirror — as stiffly cold, warm-hearted, arrogant, friendly, confused, accurate, facetious, serious, indifferent, helpful, or whatever you are. Don't imitate anybody else, either, unless you want to show up as a parrot or a parodist. Be yourself. And your honest expression will create its own style, the style exactly right for you! ★ ★ ★

CALENDAR OF THE GAS INDUSTRY

MARCH 1956

12-16 National Association of Corrosion Engineers, Hotel Statler, New York.

15-16 American Trade Association Executives, Washington conference, Statler Hotel, Washington.

16 Metropolitan Heating and Air Conditioning Council, annual meeting, Hotel Statler, New York City.

19-21 Mid-West Gas Association, Hotel Fontenelle, Omaha, Nebr.

22-23 NEGA, annual meeting, Hotel Statler, Boston.

22-23 Oklahoma Utilities Association, annual meeting, Biltmore Hotel, Oklahoma City.

23-24 Indiana Home Economic Association, French Lick, Indiana.

APRIL 1956

3-4 AGA research and utilization conference, Cleveland, Ohio.

3-5 Annual corrosion control short course, University of Oklahoma, Norman.

4-6 AGA General Management Section, spring conference, Conrad Hilton Hotel, Chicago.

5 GAMA 7th annual automatic gas range conference, Hotel Pierre, New York.

6 Maryland Utilities Association, annual business conference, Lord Baltimore Hotel, Baltimore, Maryland.

13-14 Florida-Georgia Gas Association general management conference, Lakeside Inn, Mount Dora, Florida.

14-15 SGA conference on use of electronic computers by engineering personnel, Hilton Hotel, El Paso, Texas.

16-18 National Conference of Electric and Gas Utility Accountants, Hotels Biltmore and Commodore, New York.

16-19 AGA sales conference on industrial and commercial gas, Hotel Roanoke, Roanoke, Virginia.

17-19 Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, Oklahoma.

19-20 Indiana Gas Association, French Lick Springs Hotel, French Lick, Indiana.

19-21 GAMA annual meeting, The Greenbrier, White Sulphur Springs, West Virginia.

23-25 SGA convention, Dallas, Texas.

23-25 AGA Mid-West regional gas sales conference, Edgewater Beach Hotel, Chicago.

30-May 2 Chamber of Commerce of the United States, annual meeting, Washington.

MAY 1956

3 NEGA operating division meeting, Sheraton Biltmore Hotel, Providence, Rhode Island.

6-9 LPGA convention and trade show, Conrad Hilton Hotel, Chicago.

7-10 AGA distribution, motor vehicles and corrosion conference, Congress Hotel, Chicago.

7-11 National Restaurant Association convention and exposition, Navy Pier, Chicago (AGA exhibit).

7-11 AGA commercial gas school, Edgewater Beach Hotel, Chicago.

7-11 Natural Gas & Petroleum Association of Canada, General Brock Hotel, Niagara Falls, Ontario.

9-11 American Welding Society Show, Memorial Auditorium, Buffalo, New York.

10-11 AGA gas supply, transmission and storage conference, Conrad Hilton Hotel, Chicago.

15-18 Heating, Piping, Air Conditioning Contractors National Association, Kentucky Hotel, Louisville, Kentucky.

16-18 AGA chemical engineering and manufactured gas production conference, Benjamin Franklin Hotel, Philadelphia.

22-24 Pennsylvania Gas Association, Pocono Manor Inn, Pocono Manor, Pennsylvania.

24-25 Natural Gas and Petroleum Association of Canada, Sheraton Brock Hotel, Niagara Falls, Ontario.

JUNE 1956

4-7 Edison Electric Institute, Atlantic City, New Jersey.

4-8 National Fire Protection Association, Hotel Statler, Boston.

4-29 Gas Technology Short Course, North Carolina State College, Raleigh, North Carolina.

14-15 AGA accounting section, managing committee, The Homestead, Hot Springs, Virginia.

17-22 American Society for Testing Materials, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

24-27 Canadian Gas Association, Manoir Richelieu, Murray Bay, Quebec.

25-26 Michigan Gas Association, Grand Hotel, Mackinac Island, Michigan.

26-29 American Home Economics Association, Armory, Washington, D. C.

JULY 1956

9-Aug. 8 Gas Technology Short Course, North Carolina State College, Raleigh, North Carolina.

16-20 Western Summer Radio-Television and Appliance Market, Western Merchandise Mart, San Francisco.

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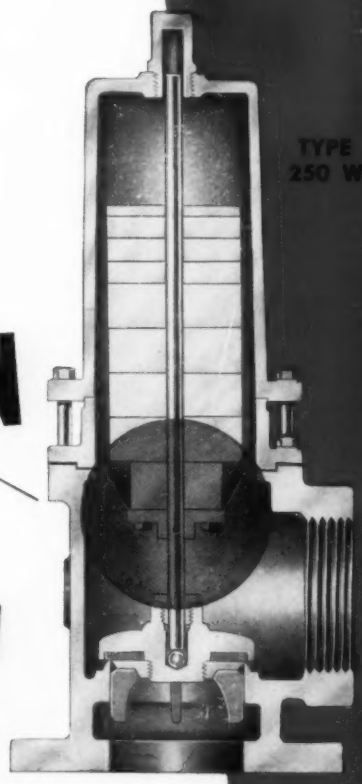
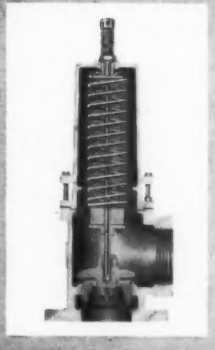
WHAT A DIFFERENCE A "D" MAKES in the NEW CHAPLIN-FULTON High Capacity Safety Valves



"D" stands for diaphragm, and what a difference it makes in the discharge ability of the new Chaplin-Fulton High Capacity Safety Valves—2½ times more flow capacity. After initial opening, the discharge pressure acting upward on the diaphragm insures maximum opening, and guarantees full flow with minimum increase in in the blowing pressure. This means greater protection for the users of Chaplin-Fulton Type 250 Safety Valves, adaptable in three models to all gas systems from ounces to 100 pounds. Sizes 2" to 6" inclusive.



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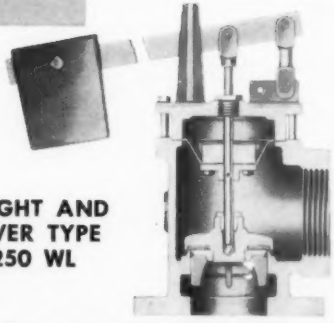

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AGA Sponsors Second Legal Symposium on Gas Legislation

The American Gas Association will sponsor a second legal symposium covering various phases of the natural gas legislation now before Congress. The symposium will be held at the Waldorf Astoria Hotel in New York City on April 9, 10 and 11.

Discussions will cover a broad outline of legislation presently before Congress. Procedural aspects of the Harris-Fulbright bills from the viewpoints of producer, pipe line and distributing company will be analyzed. Another topic at the meeting will be the impact of these bills on contract prices.

One session of the symposium will be devoted to explanations and interpretations of recent judicial decisions on cases involving the Natural Gas Act. The discussion also will include other problems pertaining to distribution, underground storage and other operational topics. The outcome of the Harris-Fulbright bills in Congress will suggest other topics that will appear on the program.

Martin Elliott Joins IGT Research Staff as Director

Dr. Martin A. Elliott, research professor at Illinois Institute of Technology, has been appointed director of the Institute of Gas Technology.

Dr. M. A. Elliott

He assumed the directorship of the institute — education and research facility of the nation's gas utility industry — on February 1.

Established in 1941 and maintained by the gas industry, the facility is affiliated with Illinois Tech and is headquartered at the IIT Technology Center on Chicago's near south side.

The gas institute's staff of 60 scientists and technicians provide specialized education for present and future employees of the industry and perform research relating to the production, transmission, distribution, and utilization of natural and manufactured gas.

Dr. Elliott is a gas engineer who has been a professional staff member of Illinois Tech's mechanical engineering department since 1952.

Employees of the Spokane Gas Company compiled the year's best employee safety record of all liquified petroleum gas distributing companies in the United States in 1954 and have the American Gas Association's annual safety award to prove it.

C. J. Melrose, left, manager of operations, is receiving the award from Frank A. Woodworth, Spokane Gas Company director and consultant. Second from left is Charles Jolley, shop foreman, and Glen E. Stewart, plant foreman.

LPG Convention Program Set for May in Chicago

The Liquefied Petroleum Gas Association's annual convention May 6-9, 1956, will be a 25th birthday party, celebrating the silver anniversary of the national organization of LPG marketers and suppliers. The meeting and trade show will be staged at Chicago's Conrad Hilton Hotel.

The association's past presidents will be honored during the session. The group to be honored includes the first president, Mark Anton of New Jersey, who presided over the first meeting in 1931 when the organization was known as the National Bottled Gas Association.

Already 236 booths for the annual trade show have been sold out of the 240 spaces available. Displays will show new appliances and equipment items and will be seen by an estimated 4000 conventioneers.

Natural Gas Common Stock Prices Gain 8.2 Per Cent

Higher earnings and larger disbursements to stockholders during 1955 were reflected in the market action of natural gas common stock prices that recorded a year to year gain of 8.2 per cent. The annual average dividend rate of $1.71 per share at the end of 1955 resulted in an increase of 7.6 per cent over the indicated dividend rate at the end of 1954. Based upon current market prices the resultant yield of 4.61 per cent was nearly the same as was obtained one year earlier.

Stockholders of common stock equities in transmission companies received not only an 11.7 per cent increase in dividend payments, but also an increase of 16.4 per cent in market value of their holdings during the last calendar year. As a result the yield was 3.2 per cent below the corresponding period one year ago. Dividend payments on distribution company stocks were 10.4 per cent higher during the year. As the common stock price index rose only 6.2 per cent, the return to the natural gas stock investors increased 4.0 per cent over last year's level to a yield of 4.91 per cent.

The following table lists stock prices, dividends and yields for 10 transmission companies, 10 distribution companies, and a composite group consisting of 30 companies, including the above two groups and 10 integrated systems having both transmission and distribution facilities.

Natural Gas Company Stock Prices, Dividends and Yields

	1955					1954	Ranges 1955-1954
	Dec. 30	Dec. 23	Dec. 16	Dec. 9	Dec. 2	Dec. 30	high low
10 Gas transmission common stocks							
Price ($ per share)	47.20	46.74	46.52	47.51	48.54	40.54	48.77—34.09
Dividend ($ per share)	2.01	2.01	2.01	2.01	2.01	1.80	2.01— 1.68
Yield (%)	4.26	4.30	4.32	4.23	4.14	4.40	4.93— 3.93
10 Gas distribution common stocks							
Price ($ per share)	28.10	28.09	27.68	28.00	28.18	26.47	29.40—21.46
Divdiend ($ per share)	1.38	1.38	1.38	1.38	1.38	1.25	1.38— 1.15
Yield (%)	4.91	4.91	4.99	4.93	4.90	4.72	5.36— 4.48
30 Natural gas common stocks*							
Price ($ per share)	37.10	37.07	37.04	37.52	37.85	34.30	37.85—28.37
Dividend ($ per share)	1.71	1.71	1.71	1.70	1.70	1.59	1.71— 1.49
Yield (%)	4.61	4.61	4.62	4.53	4.49	4.64	5.22— 4.29

* Includes 20 gas transmission and distribution stocks included above, plus stocks of 10 integrated companies.

70,000 Flow Calculations Tabulated in New Manual

A new manual, "AGA Flow Constants" for orifices where flange taps are used, has been published by The Foxboro Company, Foxboro, Massachusetts, to speed the computation of orifice sizes, coefficients and flows. Priced at $10 per copy, it saves engineering time in the gas, oil and chemical industries where accurate flow measurement requires precise calculation of metering equipment.

Compiled as a supplement to "Principles and Practice of Flow Meter Engineering" by L. K. Spink, the manual contains a total of 77,811 separate flow calculations evaluated to six figures. These include values of S for an infinite Reynolds number, values of E, and values of K_0 derived from the equations developed by Dr. Buckingham and used by AGA and ASME. Figures are presented in d/D steps of 0.001 from 0.100 to 0.800 for each of 37 line sizes from 1.535 in. I.D. to 29.25 in. I.D.

The 111 pages of tables were photographically reproduced from calculations made by automatic computer machines, thus eliminating the possibility of typographical errors. Spot checks of calculations were made to rule out possibilities of errors in the operation of the computer.

Use of the tables will save time in computing odd orifice sizes, odd pipe sizes, round-number coefficients and orifices for direct-reading gas meters where the line pressure is held constant.

Cascade Natural Completes First Financing for Expansion

The first phase of Cascade Natural Gas Corporation's financing, which will total more than $20,000,000 in the next several years, has been completed.

The money is to finance the initial expansion of Cascade's system for the distribution of natural gas in 25 Washington, Oregon and Idaho communities. Long range estimates include at least another $10,000,000 to be spent by Cascade in serving the growing communities and the new industries that plan to locate in their service area.

1955 Index

The editorial index of all articles published in **The American Gas Journal** during 1955 is now available. Subscribers wishing to receive a free copy should write on company letterhead to AGJ, P. O. Box 1589, Dallas 21, Texas.

SNUG TO THE WALL of a railroad underpass is the trench being dug by this compact Cleveland "Baby Digger." Its ability to put the edge of a trench within less than two feet of a parallel wall is but one of this Cleveland's many practical operating advantages.

DIGGING CLEAN AND FAST the same Cleveland "Baby Digger" turned out high daily production on this job. With more than 30 usable digging speeds at the operator's command, the Cleveland cut cleanly through pavement and heavy root growth for trench 22 inches wide by 41 inches deep. Performance like this has made Clevelands *first choice* in the gas industry for over 30 years.

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Super bending quality and workability speeds construction . . .

Lone Star API Line Pipe

There's real economy and extra speed in construction when you use Lone Star pipe. Lone Star's convenient pipe inventories, the direct haul of the pipe from the mill, the stringing of the pipe along the right-of-way without rehandling, superior bending quality . . all these facts contribute to the sweeping trend to Lone Star.

Lone Star's vast, completely integrated steel plant was especially built for and dedicated to serving the dynamic oil and gas industries. Lone Star meets API specifications.

Neighbor, wherever you are, specify Lone Star . . and we both get a good deal!

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Tulsa, Oklahoma | Wichita Falls, Texas | Shreveport, La.

FPC REPORT

IROQUOIS GAS CORPORATION has applied to the FPC for authority to develop a new underground gas storage area in New York state and to construct pipe line facilities to serve it. Included in the project, at an estimated cost of $2,877,200, are 36 miles of line, drilling of 16 wells, and reclaiming or reconditioning of 64 existing wells. A 900-hp compressor station is also included.

SOUTHWEST GAS CORPORATION of Barstow, California, and MONTANA POWER COMPANY, Butte, Montana, have been exempted from regulation under the Natural Gas Act in accordance with terms of the Hinshaw Amendment. Southwest becomes the 80th company to be exempted, and Montana Power is the 81st.

ATLANTIC SEABOARD CORPORATION has proposed in an application filing the construction of 86 miles of pipe line this year. Included in the project, estimated to cost $8,521,000, are 31 miles of loop line to parallel sections of the company's existing 26-in. line in Virginia and West Virginia, and a 55-mile line connecting the company's Lost River, West Virginia, compressor station to its Bickers compressor station in Virginia, interconnecting the firm's 26-in. and 20-in. lines.

A NEW 13 BY 19 INCH MAP of major natural gas pipe lines in the United States, revised as of December 31, 1955, has been issued by the FPC. The five-color map, which shows major existing lines, those under construction, those authorized and not started, and proposed lines pending commission action, is scaled 170 miles per inch. Each pipe line is numbered to refer to an index of operating companies, with 120 firms represented. Copies are available from the FPC, Washington 25, D. C., at 25 cents each. Order number is FPC M-45.

TEXAS EASTERN TRANSMISSION CORPORATION's proposed plans to import natural gas from Mexico and to build new facilities on its system will be heard by the FPC commencing March 19. The company proposes to import up to 200,000,000 cu ft daily at the International Boundary. New facilities proposed included a total of 1132 miles of pipe line and 70,780-hp in compressor facilities.

Men At Work IN THE GAS INDUSTRY

● **Bazil V. Edmunds** has been appointed photographer for The Peoples Natural Gas Company and New York State Natural Gas Corporation. He will handle photographic and public relations assignments.

● **Vernon M. F. Tallman** has been elected a vice president of three companies. For Brockton Taunton Gas Company, Brockton, Massachusetts, and Springfield Gas Light Company, Springfield, Massachusetts, Tallman will succeed **Frank S. Clifford** who has retired after 53 years of service, but will continue as a director. Tallman has also been elected a vice president for Fitchburg Gas and Electric Light Company, Fitchburg, Massachusetts.

● **B. Frank Harrison, Jr.,** controller and assistant treasurer, LaGloria Oil and Gas Company, Corpus Christi, has been elected to membership in the Controllers Institute of America.

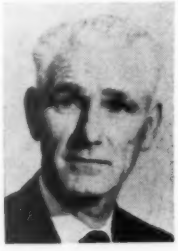
● **E. K. Wilkins** has been made vice president in charge of construction for Ebasco Services, Inc., and **W. H. Colquhoun** has been made vice president in charge of engineering, and **K. W. Reece** has been appointed executive vice president.

● **Cecil E. Loomis** has been elected senior vice president of The Columbia Gas System, Inc. Also elected were: **Francis H. Crissman,** vice president and chief financial officer and **H. Edwin Olson,** vice president and secretary of the corporation. Olson, also a director, replaces **Dale Parker,** retired. **Alan A. Cullman** has been elected a vice president and will be in charge of economic research. **Loring E. Heckman,** also a newly elected vice president, will be in charge of operations and planning for Columbia.

● **W. T. Thagard, III,** has been appointed director of plans and economic research for Texas Eastern Transmission Corporation. He joined Texas Eastern in 1947 as administrative engineer.

● Appointment of four gas industry veterans to new executive posts has been announced by General Gas Corporation. **Richard M. Mills,** former president of Mills Gas and Appliance Company, Inc., Louisville, Georgia, was elected vice president and general manager of General Gas Corporation's Eastern division headquartered in Macon, Georgia. **L. Hughes Browning,** former vice president and general manager of Radiant Gas Service, Inc., a subsidiary of Georgia Gas and Appliance Company, Inc., was named manager of operations for the firm's Eastern division. **Martin F. Dryden, Jr.,** was elected vice president and general manager of General Gas' Western division headquartered in Baton Rouge, and **Joseph Aron** was appointed purchasing agent for the Western division.

R. F. Mills



L. H. Browning

M. F. Dryden

Joseph Aron

● **E. J. Ferguson** has been promoted to assistant general superintendent of distribution in the Pennsylvania and West Virginia Divisions of Equitable Gas Company.

● Promotions in the Gas Department of Public Service Electric and Gas Company have been announced as follows: **John A. Lane,** from superintendent of distribution, Newark district, to division staff engineer, Essex division. **William L. Heuser,** from assistant superintendent of distribution, Newark district to district superintendent, Newark district. **Frank McQuade,** from senior designer, to chief draftsman, gas engineering department. **William C. Diederich,** from plant superintendent, West End Gas Works, to division staff engineer, distribution department, Bergen division.

● Promotions at Equitable Gas Company are: **George M. Probst,** Sharpsburg, to Manager of Accident Prevention. He was formerly supervisor of safety and welfare. **Howard W. Taylor,** Gibsonia, advanced to Supervisor of Safety and Welfare, and **Alex Gray,** Millvale, moved up to Supervisor of First Aid Training.

● **Ben O. Eakley** has retired as district manager of Lone Star Gas Company after 36 years service in Gainesville, Texas. He is succeeded by **James B. Smith,** former Lone Star district manager at Commerce, Texas.

● United Gas Companies have announced the advancement of five Shreveport men to executive positions. **Ed Parkes** has been named vice president and general manager of United Gas Corporation. He also succeeds the late M. A. Abernathy as a director of the corporation. **M. V. Cousins** is a new vice president of United Gas Pipe Line Company. **C. C. Barnett** is also a new vice president and a director of United Gas Pipe Line Company. **D. D. Dillingham, Jr.** is assistant to Parks. **V. S. Brennan** is the new director of personnel for United Gas Corporation, United Gas Pipe Line Company and Union Producing Company.

B. V. Edmunds

V. M. F. Tallman

C. E. Loomis

F. H. Crissman

H. E. Olson

A. A. Cullman

L. E. Heckman

C. A. Schlegel

O. A. Gray

● **Carl A. Schlegel** has been appointed vice president in charge of United Engineers and Constructors, Inc. gas division. He replaces **Charles W. Hunter,** who is retiring after more than 50 years in the gas business. Succeeding Schlegel as gas sales manager is **Oscar A. Gray,** a former gas sales engineer with the company.

● **Gerald E. Wilson** has been elected vice president of Pittsburgh Group Companies of Columbia Gas System, succeeding the late **Earl D. Cutter. James G. McKee** has been named superintendent of the distribution department, succeeding Wilson.

Executive duties of vice president **Dan J. Egan** have been expanded to include employee relations, purchasing information, civil engineering, service and reproduction departments.

C . R. Holloway, Jr.

A. J. Blair

● **Charles R. Holloway Jr.** has been elected to the new office of vice president in charge of marketing for Portland Gas and Coke Company, Portland, Oregon. He will head all Gasco sales activities.

● **Dr. Albert J. Blair,** Waynesburg, Pennsylvania, physician, has accepted a position as Assistant Medical Director of Consolidated Natural Gas Company. He will have his offices at Two Gateway Center, Pittsburgh, headquarters of The Peoples Natural Gas Corporation, Consolidated subsidairies.

● **Albert G. Neal** has been elected president of Fitchburg Gas and Electric Light Company, Fitchburg, Massachusetts. He succeeds **Frank S. Clifford,** who is retiring after 53 years of service. Clifford will remain as a director. Neal has been with the company since 1914.

Deaths

Henry F. Preddy

Henry Frank Preddy, 59, supervisor, Meter Department, General Division of Distribution, Lone Star Gas Company, died of a heart attack November 12 in Dallas. Preddy had been with Lone Star since 1917.

Herbert C. Gross

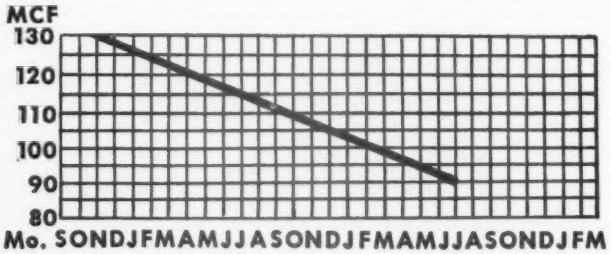
Herbert C. Gross, 66, manager of Philadelphia Electric Company's Delaware division, at Chester, Pennsylvania, died November 23 after an illness of three months.

Gross was an active member of many industrial organizations, such as the American Gas Association, Edison Electric Institute, Pennsylvania Electric Association, and the Pennsylvania Gas Association. He was well known for his civic and community activities, having been a director and past president of the Chamber of Commerce of the City of Chester and Delaware County, and a director of the Delaware County Manufacturers' Association. He was also a director of the Delaware County National Bank and the Pennsylvania Savings Loan and Building Association.

Case history #6

"un-accounted for"

DOWN 30%!



A large Southern distribution system had an "un-accounted for" of over 132 MCF.

With SOUTHERN CROSS FORESTERS service their "un-accounted for" has been reduced to 92 MCF, a reduction of over 30%!

This is another example of the wisdom and profit in turning leak location and repairs over to SCF.

We have a plan to fit your system—

Plan 1. Vegetation survey — for residential areas.
Plan 2. Safety survey — for congested areas.
Plan 3. Combination survey — for coverage of the entire distribution system.

Our service includes completely equipped repair crews as well as consultants. With SCF crews "un-accounted for" losses are reduced without costly build-up of personnel or equipment.

SOUTHERN CROSS FORESTERS

3677 Buford Highway Atlanta, Georgia

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